

## Editorial

This issue of *Phelsuma* covers our usual range of species descriptions and records, this year from Seychelles, the Chagos and Madagascar. We have made one departure from our normal publishing this year with the publication of our first open-access on-line supplement. The supplement (*Phelsuma* 17A) is dedicated to 'Climate change in the Western Indian Ocean' and is freely available on our web-site at

<http://islandbiodiversity.com/Phelsuma17A.htm>

The first paper has been published:

Will climate change affect terrapin (*Pelusios subniger parietalis* and *P. castanoides intergularis*) conservation in Seychelles? – Bombi, P. *et al.*

Further papers are planned on climate change predictions and on sea level rise in the Western Indian Ocean.

Scientific publication has been in a period of great change over the past few years and open access publishing is expanding rapidly. It seems increasingly clear that this is the future of scientific publication as budgets for subscription journals contract, publication costs soar and internet technology continues to develop. For scientists this is a welcome development in some respects, increasing the potential audience for their work and increasing the ease of access to some journals. However, scientists lacking access to good internet facilities will increasingly find that they cannot keep up to date, making their work unpublishable and hence irrelevant. This will be an even more serious problem for conservationists and amateur biologists with even more basic facilities. It is now inevitable that only those with access to high-speed internet will be able to keep up with scientific, technological, social and policy changes in the 21<sup>st</sup> century. With the environment changing faster than ever before in recorded human history the need to keep up to date has never been more pressing. This is a depressing trend for many in under-resourced or mismanaged parts of the world but we must all make what effort we can to keep abreast with these changes. For a small organisation like the Nature Protection Trust of Seychelles this means that we are always making do with facilities that are just adequate for the latest changes. Our publications have always been designed to cover the costs of production, but this becomes increasingly difficult and for some time it has been clear that although we do not make a financial loss on *Phelsuma* and *Birdwatch*, this is only because the editing and production is voluntary. Our purpose is not to make a profit but to disseminate information and in the future the most effective way of doing that will only be on-line. Over the next few years *Phelsuma* will be moving towards on-line publication and we expect to have become a fully open access journal by 2012.

J. Gerlach  
Editor

## Chairman's Report

Wherever one is, or whatever one does, there has been no escape from the fallout of the global financial crisis. Funding for conservation projects has become more difficult to access as all efforts are made to support failing banks and industries. In our region the situation was further complicated by the political upheaval in Madagascar where the regional office for Conservation International is based. It was, therefore, with great relief that we received support from C.I. Madagascar for a project in cooperation with the Ministry of Environment, to look at the confirmed sheath-tailed bat roosts on Mahé. The project aims to establish the populations in each roost and to initiate habitat restoration in the areas around the roosts.

This last year environmental non-government organisations in Seychelles have been involved with government, the World Bank, GEF and UNDP in a large project aimed at mainstreaming biodiversity into the production sector. This has involved a substantial NGO co-financing commitment, where the value of work by NGOs is used to support the local funding portion of the GEF financing. While there is some financial benefit to individuals who are accepted as consultants, the final beneficiary will be the government which will possess documentation aimed at helping all sectors to understand the value of biodiversity. NGO involvement is directed towards voluntary attendance at workshops and presentations and a lot of time reading and commenting on documentation. As the main stakeholders with the most involvement with the biodiversity of the islands, it is good that NGOs are there to make valuable input but the benefit to them is not easily discernable.

This year, two new publications were produced, based on the Indian Ocean Biodiversity Assessment (IOBA) "The Diptera of the Seychelles Islands", edited by Justin Gerlach, was published by Pensoft in their Faunistica 85 series. This publication includes accounts of all 630 species of flies (Diptera) recorded in the Seychelles islands and is the result of the collaboration of 27 Diptera taxonomy specialists.

"Key Biodiversity Areas of the Seychelles Islands" by Justin Gerlach was published by Backhuys Publications, a division of Magraf Publishers GmbH Scientific books. This publication is a synthesis of the data collected during the IOBA 2000-2005 and has used the Conservation International biodiversity hotspot concept to identify key biodiversity areas in Seychelles.

A steady stream of guests from Labriz Silhouette, the only hotel on the island, has kept us busy this year. The projects have benefited from increased sales of fund-raising items and donations from the visitors. We are grateful to Labriz and their guests for their support.

We should also like to thank the following individuals and organisations for their

support:

Conservation International  
Labriz Silhouette  
Island Development Company

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Steve Barnes

Project funding  
Logistical and project support  
Accommodation and secondment of one  
fieldworker to the tortoise project  
Publication funding  
Donations of terrapin food  
Honorary Auditors  
Donations of terrapin food

### Volunteers

As always, we wish to express our sincere thanks to the following people who have volunteered their time and energy to support our projects.

Ann and Bill Truscott kindly filled in for us during our absence in early May. In late March, Sussex University were on Silhouette for their annual field course. This year they made an impressive impact on alien shrubs at Jardin Marron. Two volunteer organisations with whom we have cooperated in the past did not return to the island this year. Earthwatch International had started a marine programme around Silhouette but were refused permission to return, ostensibly due to the non-production of a report. For three seasons Global Vision International had monitored turtles on the beach at Grande Barbe but were having boat transfer problems and considered having to walk across the island to Grande Barbe as too strenuous and sometimes dangerous.

### Scientific and Other Visitors

Sara Rochas and two assistants were on Silhouette from 2<sup>nd</sup> to 4<sup>th</sup> June as part of a herpetological genetics research project.

Also in June, Michele Martin with a group of students from the National Institute of Education visited the projects and Information Centre.

On 24<sup>th</sup> June, Lindy McGregor from ICS came to collect terrapin blood and faecal samples for the FFEM project to establish a terrapin project on North Island.

In September, Prof. Paul Racey from the IUCN Species Survival Commission's bat specialist group and Dr. Steve Goodman, visited the sheath-tailed bat roost on Silhouette with Selby Remie from the Ministry of Environment.

A group of visitors from Palau and Philippines, under the umbrella of the Micronesian Challenge, came to Silhouette on 7<sup>th</sup> March to see our conservation projects.

Steen Hansen and Victorin Laboudallon were on Silhouette on 13<sup>th</sup> March to collect photographic data for a new book on plants.

### Overseas Visits and Meetings

We attended the Fourth World Conservation Congress of IUCN in Barcelona in October. Our main interests lay in the Species Survival Commission meetings and presentations related to small island states.

In May we visited Dr. Roger Bour at the Musée de l'Histoire Naturelle in Paris, to see the *Testudo gigantea* specimen and the Aldabra tortoises in the Jardin des Plantes.

In April our Science Co-ordinator was invited to take part in the University of La Réunion symposium entitled “Darwin 2009 - Darwin et la théorie de l'évolution : Symposium Biodiversité et Evolution” bringing together scientists from the region and from France to commemorate the 200<sup>th</sup> anniversary of the birth of Charles Darwin and the 150<sup>th</sup> anniversary of the publication of the “Origin of Species”.

### Seychelles Giant Tortoise Conservation Project

The fertility problems occasioned by the major disturbance from building operations opposite the tortoise enclosures reached a low point this year. Only three eggs hatched from 50 eggs, bringing the total number of tortoises bred in the breeding project to 153. They are all growing well and making ever-greater demands on our ability to feed them.

Fortunately the building operations are now over and a relative calm has returned to the area. The buildings have remained unoccupied for the past six months. During this calm period our *Dipsochelys hololissa* female, Josephine, has nested three times and laid 61 eggs.

Although not having a direct impact on the Giant Tortoise project, we might be faced with yet another biological name change for the Indian Ocean tortoises. In an unusual and highly controversial petition to the International Commission for Zoological Nomenclature, a group of mostly non-specialist individuals, many with no taxonomic background, have asked that the Aldabra tortoise be named *Testudo gigantea*, which has recently been considered to be a Brazilian tortoise and not an Indian Ocean species. If accepted this will fix the Aldabra tortoise as *Aldabrachelys gigantea* and require the other Seychelles and Madagascar species (living and extinct) to be transferred to the unfamiliar genus *Aldabrachelys*. Counter arguments have been put forward that the rules of zoological nomenclature be allowed to operate and all these species to remain in *Dipsochelys*.

### Seychelles Terrapin Conservation Project

For the second year running, there have been no eggs laid. Coincidentally, this is the same problem we have had with the tortoises. The building operations may not have been the problem but cannot be ruled out.

We have continued to support the FFEM project with ICS to introduce *Pelusios subniger* to North Island. Terrapins have been kept in quarantine in our ponds between the time of their capture and their subsequent release on North. Blood and faecal samples were taken from the first batch prior to the transfer to North where they have been monitored as much as it is possible to monitor such secretive animals.

### Silhouette Conservation Project

Surveys and monitoring of all aspects of the island's biodiversity have continued throughout the year. More emphasis was placed on gathering weather data in the areas of Jardin Marron and Mon Plaisir as a baseline for future climate change monitoring.

In May the Ministry of Environment published its intention to declare Silhouette a new National Park and invited comments from the general public. With support from international conservation groups concerned with bats, we put in a request to have the area that includes the old cemetery included in the protected area as this is within the feeding zone of the sheath-tailed bats. This proposal was accepted by the Ministry.

In March, I met a member of staff of Per Aquum, the company that was to build a hotel at Grande Barbe, who told me that the government had refused them permission to build an access road across Silhouette. This news, plus the proposed National Park will ensure that this treasure house of Seychelles biodiversity will be safe from any future inappropriate development.

### Seychelles Sheath-Tailed Bat Project

We completed the project on Silhouette funded by Conservation International (Madagascar) this year. The project greatly increased our ability to observe the bats via further CCTV links and to record and study vocalisation. This successful project has led to further funding from C.I. for a second phase which will investigate the few remaining roosts on Mahé and to work with MENR (our partner in this project) in improving habitat restoration along the lines of our habitat restoration project on Silhouette.

We have worked on the forest restoration throughout the year with the gardening staff from Labriz hotel. Their cooperation and support has made a great deal of difference and has eased the strain of 10 years of voluntary physical work by three NPTS members, trying to save the critically endangered sheath-tailed bats and their habitat.

Personally, I would like to thank the General Manager and gardeners of Labriz Silhouette for their continued support. I wish also to thank Gill Gerlach, our Honorary Secretary, for dealing with the ever-increasing bureaucratic workload and hands-on conservation work. And finally, many thanks to our Science Co-ordinator who is the driving force behind NPTS and responsible for yet another impressive issue of this, our annual scientific journal.

R. Gerlach  
Chairman

## 2008 Publications

[Ami = Amirantes; Ald = Aldabra; Sey = Seychelles]

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## A new species of *Coenosia* Meigen, 1826 from the Seychelles Islands (Insecta, Diptera: Muscidae)

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**Abstract:** A new species, *Coenosia extincta* sp. nov., is described from a single male from Mahé, collected in 1892. It has not been found since then, and is now believed to be extinct.

**Keywords:** Diptera, Muscidae, *Coenosia*, Seychelles, new species

### Introduction

The recently published book on the entomology of the Seychelles (Gerlach 2009) includes a brief review of the family Muscidae by the present author (Pont 2009). At the time that this chapter was being prepared, a small amount of unidentified material was available from the Muséum National d'Histoire Naturelle, Paris (MNHN), which included one male of a small species of the muscid genus *Coenosia* Meigen, 1826. Further study has shown that this is in fact an undescribed species and that it has not been found since it was first collected by the French entomological explorer, Charles Alluaud, in 1892.

The fact that this species has not been collected since 1892, despite the relatively large amount of fieldwork carried out on Mahé Island in the Seychelles (see Gerlach 2009), suggests that it is no longer present on the island. The possibility that the specimen might have been mislabelled was also considered. However, the peculiar dark markings on the scutum and abdomen are unique and exclude the possibility that it might be one of the described mainland African species. The group of species to which it belongs, which Emden (1940) assigned to a separate genus *Caricea* Robineau-Desvoidy, 1830, is very speciose in the Afrotropical region but there are relatively few species described from the Palaearctic and Oriental regions. It is also the case that such a “*Limnophora*” type of black-and-grey scutal and abdominal pattern is found in Afrotropical species of a number of genera (especially *Helina* Robineau-Desvoidy, *Phaonia* Robineau-Desvoidy, *Hydrotaea* Robineau-Desvoidy, *Spilogona* Schnabl) and could justifiably be thought of as an Afrotropical regional colour pattern.

In view of the fact that this appears to be an endemic species that is no longer present on the Seychelles Archipelago, the species name *extincta* has been selected.

## *Coenosia extincta* sp. nov.

### Holotype

Male, SEYCHELLES: Mahé, 1892 (Ch. Alluaud), in MNHNP.

Alluaud (1893) collected on the Seychelles during March, April and May 1892, but no further details as to precise locality and date are present on the specimen labels.

### Description

Male. *Head*. Slightly shrivelled, but condition good. Ground-colour black. Frons broad, subparallel, just above lunula about as wide as an eye (in frontal view). Eye bare. Fronto-orbital plate whitish pruinose, silvery below; parafacial, face, gena and lower occiput silvery pruinose, rest of occiput light grey. Fronto-orbital plate narrow, at middle 1/3 width of frontal vitta at this point. Frontal triangle distinct, reaching to just below level of orbital seta. Only 1 vertical, very long. Upper post-ocular setulae in one row. Ocellar seta long, subequal to orbital seta. 3 pairs of inclinate frontal setae, with a fourth tiny pair at lunula; 1 pair of reclinate orbitals. Antennae dark brown, the articulation between pedicel and postpedicel orange; postpedicel moderate, twice as long as pedicel (frontal view), falling short of epistoma by half its own length, the anterior tip rounded and not produced into a point. Arista plumose in basal half, the longest combined hairing equal to length of postpedicel. Parafacial narrow, everywhere wider than diameter of anterior ocellus. Vibrissal angle behind level of profrons; vibrissae strong, crossed. Gena moderate, the depth below lowest eye-margin equal to width of postpedicel. Mentum of proboscis dark brown, glossy. Palpus dark brown. - *Thorax*. Ground-colour black. Scutum light grey dusted, with a black transverse postsutural band that is bordered anteriorly by the suture and posteriorly by the 2nd dorsocentral, and also extends laterally over post-alar callus; scutellum black, undusted; postpronotal lobes and pleura light grey dusted. Acrostichal setulae weak, in 2 rows at suture. Dorsocentrals 1+3. Postpronotal lobes with none of the setulae spinulose; inner seta minute. 1 postsutural intraalar. 2 proepisternal setae. Lower katepisternal shorter than anterior one. Scutellum with the usual apical and sub-basal lateral setae; disc sparsely setulose. - *Legs*. Mostly black; trochanters and knees yellow, tibiae brown. Tarsomeres not modified. Fore femur without anteroventrals, posteroventral row sparse, long. Fore tibia with a strong submedian posterior seta. Mid femur without anteroventrals, with 2 long fine posteroventrals in basal half; anterior surface with several setae in basal half; 1 anterior and 2 posterior preapicals. Mid tibia with 1 long anterodorsal and 1 short submedian posterior seta. Hind femur with 2 anteroventrals in apical half, and 2 posteroventrals; anterodorsal row complete; 0 dorsal and 2 posterodorsal preapicals. Hind tibia without posterodorsals or anteroventrals; 1 long anterodorsal and 1 slightly shorter anterior seta at the same level; with strong dorsal and anterodorsal preapical setae. - *Wing*. Clear, veins yellowish-brown. Tegula and basicosta yellow. Veins bare except for costa. Costal spine inconspicuous. Cross-vein r-m slightly beyond the point where  $R_1$  enters costa; cross-vein dm-cu straight. Vein  $A_1+CuA_2$  very short, not reaching halfway from its base to wing-margin. Calypters white; lower calypter long, projecting beyond upper one by almost length of upper one. Haltere yellow. - *Abdomen*. Ground-colour black, light grey dusted and with a *Limnophora*-like pattern of black markings as follows: syntergite 1+2 mostly black; tergites 3-5 each with a complete black median vitta; tergites 3 and 4 each

with a pair of large quadrate spots, separated from the median vitta and the fore-margin by dust; tergite 5 with a pair of paramedian spots occupying posterior half of tergite; sides of tergites light grey dusted. Visible post-abdominal tergites light grey dusted. Tergite 3 with a pair of strong lateral marginals; tergites 4 and 5 each with 2 pairs of strong marginals. Sternite 1 bare. - *Measurements*. Length of body, 3.0 mm. Length of wing, 2.5 mm.

### Differential diagnosis

A small species belonging to the *semifumosa*-group of Emden (1940: 234), but immediately distinguished by the black-and-grey, "*Limnophora*" pattern of markings on scutum and abdomen.

*Coenosia extincta* can be incorporated into the key to Seychelles Muscidae given by Pont (2009) by the following couplets:

- |     |  |                          |
|-----|--|--------------------------|
| 14. | Arista long plumose  | 14a                      |
|     | Arista almost bare   | 16                       |
| 14a | Hind tibia with 1 anterodorsal and 0 posterodorsal seta. Frons with only 1 pair of reclinate orbital setae | <i>Coenosia extincta</i> |
|     | Hind tibia with 2 anterodorsal and 2 posterodorsal setae. Frons with 2 pairs of reclinate orbital setae    | 15                       |

### Acknowledgements

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## Ontogeny of the cheek-spined goby *Asterropteryx semipunctata* (Pisces, Gobiidae)

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**Abstract:** *Asterropteryx semipunctata* and the similar *A. gubbina* are compared from specimens collected at Silhouette island, Seychelles. Ontogenetic changes in *A. semipunctata* show that adult morphology is attained at 30.1mm (development of dorsal fin pennant and urogenital papilla) whereas *A. gubbina* are mature at 12.7mm. The two species are easily distinguishable on colouration at all sizes.

**Key words:** *Asterropteryx gubbina*, *Asterropteryx semipunctata*, Seychelles, Silhouette, ontogeny

The cheek-spine goby genus *Asterropteryx* Rüppell, 1828 contains 9 described species of small (less than 50mm) gobies from marine lagoons and reefs of the Indo-Pacific region. The genus is divided into two groups (Shibukawa & Suzuki 2002, 2007): the “*spinosa* complex” (*A. spinosa*, *A. bipunctata*, *A. senoui* and *A. ovata*) and the “*semipunctata* complex” (*A. semipunctata*, *A. ensifera*, *A. striata*, *A. atripes* and *A. gubbina*). The “*semipunctata* complex” is the most diverse of the two groups and *A. semipunctata* is the most widespread species, being found from the east coast of Africa to the east Pacific. Recently described *Asterropteryx* have been well described and most are highly distinctive. However, confusion between juveniles of these small species makes identifications of some individuals and populations difficult. A study of one population of *A. semipunctata* in the Seychelles islands enabled ontogenetic changes to be evaluated and this common, widespread species to be compared with the similar but smaller *A. gubbina* (Gerlach & Gerlach 2008).

### Methods

#### Study population

*Asterropteryx* populations were studied in the lagoon at Silhouette island, Seychelles (4°29'03"S 55°15'09"E) in between December 2007 and April 2009. These comprised localised populations of *A. semipunctata* and *A. gubbina* in coral rubble in the lagoon. *A. gubbina* was described from this population and was the only species located there in December 2007. Subsequently only *A. semipunctata* were located. Several individuals of *Asterropteryx* were captured and placed in an aquarium. A range of sizes was collected, from 10.1mm to 38.1mm, representing juveniles and mature adults of both sexes.

## Measurements

Fish were individually transferred into a small glass tube, restricting their movement during examination under a dissecting microscope at x10 magnification. Counts and measurements follow Shibukawa & Suzuki (2002, 2007). Cephalic sensory canals and papillae observed under a dissecting microscope at x10 and x40 magnification. Pores and canals were labelled after Shibukawa & Suzuki (2002, 2007).

## Description of *Asterropteryx semipunctata*

Dorsal fin spines VI+I 11-12, 3<sup>rd</sup> dorsal ray developed into a long, filamentous pennant in adults, this is apparent in all fish longer than 13.5mm standard length; anal fin rays I 11-15; pectoral fin rays 15-16; pelvic fin rays I, 7, the innermost may be unbranched; branched caudal fin rays 6+6; upper unbranched caudal fin rays 2-5, unsegmented; lower unbranched caudal fin rays 4-6 unsegmented; longitudinal scale rows 24-25; transverse scale rows counted from origin of anal fin upward and forward to base of 1<sup>st</sup> dorsal fin 8-9; predorsal scales 8.

Head and body rather compressed, typical for *Asterropteryx*. Eye moderately large, its diameter equal to snout length. Interorbital space narrow, with less than pupil diameter. Mouth terminal, oblique, forming an angle of about 35° with body axis. Lower jaw slightly projecting beyond upper jaw. Posterior end of jaws extending to below anterior margin of pupil. Anterior nostril a short tube without skin flap. Posterior nostril a pore, closer to anterior margin of eye than to anterior nostril. Tongue rounded or nearly truncate, anterior tip free from floor of mouth. Lower lip interrupted at symphysis. Mental flap on chin absent. 2-4 short posteriorly directed spines on posterior margin of preopercle, uppermost one situated just behind and below sensory canal pore N; all preopercular spines similar in length, uppermost one slightly longer than others. Gill opening moderate in size, lower edge extending anteriorly beyond pectoral fin base, reaching a vertical line at posterior margin of preopercle. Gill membrane attached to isthmus. No fleshy papilla-like projection on lateral margin of lateral wing of cleithrum. 1<sup>st</sup> dorsal lacking filamentous spines; 2<sup>nd</sup> spine is longest and reaches to base of 2<sup>nd</sup> dorsal. All segmented pelvic and caudal fin rays branched. Second dorsal fin higher than first, rays 1-8 uniform in length, 9-12 less than half the length of preceding rays. Pectoral fin rounded to slightly pointed, 6<sup>th</sup> ray longest, extending posteriorly to a vertical from base of anal fin. Pectoral fin rays unbranched. Pelvic fin not united at base, joined by only a rudimentary membrane; no pelvic frenum, 5<sup>th</sup> ray longest, tip reaching to base of anal fin; 5<sup>th</sup> ray 80% of fourth; all rays of pelvic fin branched. Caudal fin rounded.

Cheeks with 2-9 spines (3-8 in Silhouette specimens). Scales on head and body ctenoid with 16 cteni, except for slightly embedded cycloid scales on the anterior half of cheek, ventral surface of gill membrane, throat, nape around predorsal midline, pectoral fin base, prepelvic region and anterior half of abdomen. Snout, chin, lips, ventral surface of lower jaws and interorbital region naked. Teeth in jaws simple, conical; upper and lower jaws with about 4 rows of teeth anteriorly, narrowing to a single row posteriorly. Teeth in outermost row largest; no prominent canine-like teeth on jaws. No vomerine or palatine teeth.

Patterns of cephalic sensory systems shown in Fig. 3. Oculoscapular canal

with pores B', C (single), D (single), E, F, G, H', K' and L'; preopercular canal with N and O'. Right and left sides of oculoscapular canal fused medially between pores C and D. Five short transverse rows of sensory papillae (1, 2, 3, 4/5 and 6) below eye, row 6 divided into two parts (6s and 6i). At least one longitudinal row of sensory papillae behind chin.

**Colour in life.** Dark phase: head and body dark brown to black, iris dark brown; body scales (rows 5 and 6) with an electric blue spot in centre of scales, blue spots also present on operculum and pectoral base. All fins infuscated with dark grey spots, most concentrated on base of dorsals, and posterior half of second dorsal. Caudal peduncle uniformly dark.

Pale phase: dorsum of head and body off-white to pale grey-brown, cheeks and throat pale reddish-brown; usually no radiating bars from the antero-ventral margin of eye, some individuals may have one ventral bar running from eye to angle of jaw; iris pale reddish-brown with white spots. Small dark spots all over body; numerous large electric blue spots on operculum, pectoral base, second dorsal base (large adults) and on body. Light reddish-brown stripe on sides, 8 white patches on dorsum. Pale scales with distinct dark chromatophores centrally. White spot at base of pectoral. Caudal peduncle with a black spot on dorsal half, interrupted by a white spot at postero-dorsal end. In some individuals this extends downwards towards the ventral part of the peduncle, with a postero-ventral white patch. Peduncle not white posterior to the black band. Caudal and pectoral fins hyaline, other fins hyaline, with light brown bases.

### **Sexual dimorphism.**

Urogenital papilla distinct, long, narrow and pointed in males; female urogenital papilla short, broad and rounded or flattened. No sexual dimorphism in colouration or in filamentous pennant development.

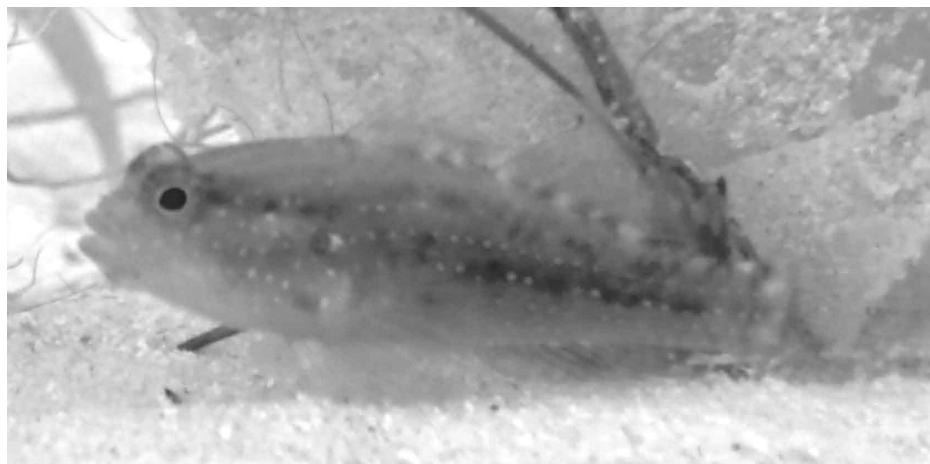
### **Onotgenetic changes**

Colouration of juveniles is very similar to that of adults. Changes in colouration include expansion of blue spots, from being restricted to the lower half of flanks and on pelvic fins in juveniles under 10mm (maximum 9.6mm), extending all over the body by 13.5mm. Juveniles may have fine white speckles on the basal half of the pectoral fins, all over the pelvics and caudal fin. The filamentous dorsal pennant is not present in small juveniles under 10mm long (9.6mm), individuals 13.5mm long have the first three dorsal spines extended, reaching the second dorsal fin. At 27.1mm the filamentous third spine is developed, reaching 1/3 of the length of the second dorsal. At 30.9mm it is fully developed, reaching half-way along the second dorsal.

The urogenital papilla is not developed until maturity, the smallest individual with a urogenital papilla was 30.9mm long.

### **Comparison with *Asterropteryx gubbina***

Differences between the two species are summarised in Table 1.



**Fig. 1.** Pale phase *Asterropteryx semipunctata* (top) and *A. gubbina* (bottom).

## Discussion

The blue-spotted or starry goby *Asterropteryx semipunctata* is a widespread species. It is a highly distinctive species with bright blue spots at all sizes studied. The typical pennant on the first dorsal fin is detectable in subadult specimens over 13.5mm although full sexual maturity (as indicated by the presence of the sexually dimorphic urogenital papilla) is only present in individuals with a standard length of at least 30.9mm, this gives an adult size range of 30.9-38.2mm. In contrast the superficially similar *A. gubbina* is mature at 12.7mm and does not exceed 17.0mm. It is probable that other diminutive species of *Asterropteryx* exist but have been assumed to be juveniles



of *A. semipunctata*. The description given above should serve to discriminate between true juveniles of *A. semipunctata* and other species.

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**Table 1.** Comparison of *Asterropteryx semipunctata* and *A. gubbina* from Silhouette island, Seychelles.

Characters		<i>A. semipunctata</i>		<i>A. gubbina</i>
		adult	juvenile	
colour pattern	caudal peduncle	black spot on dorsal half, may have postero-ventral white patch	as adult	black spot on dorsal half followed by a white vertical band
	spot pattern	body and fins	body only	absent
dorsal ray pennant present		long	>13.5mm	never
longest dorsal spine		3 <sup>rd</sup>	3 <sup>rd</sup>	2 <sup>nd</sup> or 3 <sup>rd</sup>
dorsal fin spines		VI+I 9-11	VI+I 9-11	VI+I 11-12
cheek spines		2-9	2-9	2-4
smallest adult with urogenital papilla		30.9mm	-	12.7mm
maximum size		38.2mm	-	17.0mm

## New animal species from Aldabra atoll

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**Abstract:** Two new animal species are described from Aldabra atoll, Seychelles: *Kaliella aldabrana* (Chronidae: Gastropoda: Mollusca) and *Amirantea aldabrensis* (Pentatomidae: Hemiptera: Insecta).

**Keywords:** *Amirantea*, Chronimidae, Hemiptera, *Kaliella*, Mollusca, Pentatomidae

### Introduction

During the examination of recent collections as part of the taxonomic revisions of the Seychelles fauna of the Indian Ocean Biodiversity Assessment two undescribed animal species were identified from material from Aldabra atoll. These are described below.

### Abbreviations

NMW – National Museum of Wales

NPTS – Nature Protection Trust of Seychelles

SNHM – Seychelles Natural History Museum

UMZC – University Museum of Zoology, Cambridge

### Mollusca Gastropoda ?Chronidae

The family position of many species in the Limacoidea is uncertain. The genus *Kaliella* has variously been placed in Chronidae, Ariophantidae and Helicacionidae.

#### *Kaliella aldabrana* sp. nov.

‘*Kaliella*’ sp. Gerlach 2006: 84

*Kaliella* sp. B Barnacle 1968: 54. Lionnet 1984: 241. Gerlach 1987:  
17. Gerlach & Griffiths 2002: 678. Gerlach 2006: 84

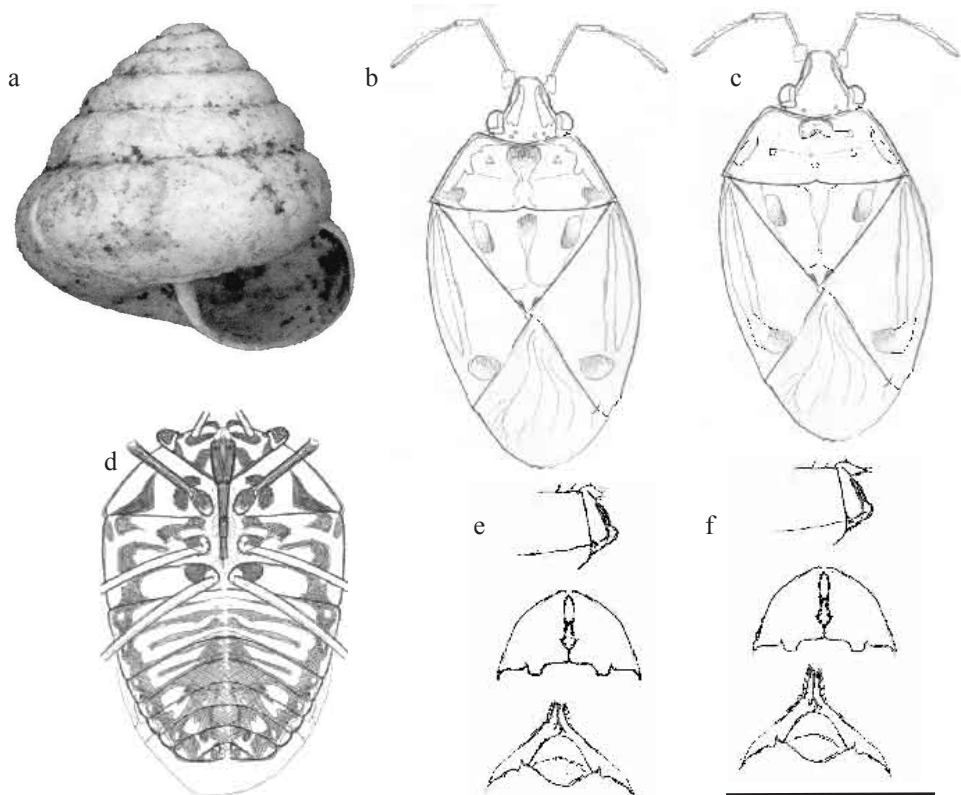
**Description** (Fig. 1): Conical with 6 whorls; apex blunt. The body whorl lacks any trace of a keel. Surface with faint irregular ribs, no other sculpture detectable. Colour light brown. Aperture subublie, quadrately lunate; peristome simple. The umbilicus is narrow, almost entirely obscured by the reflected columellar margin. Shell colour pale brown, all specimens at least partially bleached.

**Material examined:** Holotype NMW.Z.2002.027.00019; Paratype NPTS M2001.38 – all Esprit, Aldabra 16.12.2000, coll. J. Gerlach. Other specimens: NPTS M2001.7 (Polymnie 9.12.2000, coll. J. Gerlach), M2006.36 (Polymnie 14.12.2006, coll. J. Gerlach), UMZC (Esprit 16.12.2000, coll. J. Gerlach). SNHM (Aldabra 1966, ex. G. Lionnet colln.)

**Distribution:** Aldabra: Picard, Polymnie, Grande Terre and Esprit islands.

**Status:** As with all animals endemic to Aldabra this species can be considered to be Endangered due to sea level rise. This species is known from only a small number of collections. The first specimen is from 1907, several were collected in 1966 and four old bleached shells were found in 2000 (Gerlach & Griffiths 2002) and a single old shell in 2006. Searches for the species in 2006 failed to locate any fresh specimens and it is possible that this species is extinct.

**Comparisons:** *Kaliella* is a largely Asian genus of conical pyramidal shells with slightly convex whorls and a shallow suture, oblique apex, subquadrately lunate aperture and simple peristome. Many species are probably not true members of the genus. Superficially this species resembles *K. detecabilia* Sykes, 1898 of south-east Asia but has a lower spire. Three species are present in the Western Indian Ocean region: *K. barrackporensis* (Pfeiffer, 1853) (including *K. basalis* (Dohm, 1882)) and *K. soulaiana* Fisher-Piette, 1973 from Madagascar, and *K. fourneauxensis* Godwin-Austen, 1908 from Mauritius. Of these *K. aldabrana* is most similar to *K. barrackporensis* and *K. fourneauxensis* but can be distinguished by having a convex underside, no spiral striae and no keel.



**Fig. 1a.** *Kaliella aldabrana* holotype. **b, d, e.** *Amirantea aldabrensis* holotype. **c, f.** *A. gardineri*. **b-c** dorsal, **e** ventral, **e-f** parpamere lateral, dorsal and ventral. Scale bar: **a-e** 2mm, **e-f** 0.5mm

**Table 1.** Dimensions of *Kaliella aldabrana* (range, mean and standard deviation)

	Diameter (mm)	Height (mm)	H/D
Holotype NMW.Z.2002.027.00019	4.4	4.7	1.07
Paratype NPTS M2001.38	4.5	4.9	1.09
Range (n=4)	4.0-(4.33±0.24)-4.5	4.0-(4.65±0.43)-4.9	1.00-(1.07±0.06)-1.09

**Insecta**  
**Hemiptera**  
**Pentatomidae**

*Amirantea aldabrensis* sp. nov.

Distribution: Endemic – Aldabra. One male specimen collected by L. Jack, mixed scrub, Malabar island, Aldabra. April 2005. NPTS Hh2005.21

Description: Male - Head dark brown with longitudinal white marks with bluish central areas. Eyes red with white margin. White spot positioned antero-medially to each ocellus. Pronotum dark brown with white margins and central longitudinal line. Scutellum dark brown with anteroa lateral white spot and medial white mark, not reaching anterior margin. Corium dark brown with lateral white line and sub-apical white spot. Abdomen dark magenta, orange-red with white markings ventrally, red at margins. Thorax and head ventrally white with blackish markings. Rostrum dark brown.

Comparisons: This species is one of only twom members of the genus *Amirantea*. *A. gardineri* Distant, 1909 differs in the pronotal central and marginal lines being interrupted, the corium markings being joined and the scutellar markigs interrupted, apically red. The paramere is more elongate in *A. gardineri* and the antennae differ in proportions:

*A. aldabrensis*    1:2:2:2:1.5                      *A. gardineri*            1: 3:2:2.5:2

*Amirantea gardineri* is endemic to the granitic islands of Mahé (near Morne Blanc 1905, 1908) and Silhouette (widespread above 300m, 1908) where several specimens collected from *Aphloia theiformis* (Distant 1913). The species has not been located since 1908 and may be extinct. *A. aldabrensis* is knoww only from scrub habitat and appears to be scarce, being represented only be a single specimen.

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## First comprehensive avifaunal survey of PK32-Ranobe, a new protected area in south-western Madagascar

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**Abstract:** We conducted the first comprehensive bird survey of PK32-Ranobe (Atsimo Andrefana Region), a proposed new protected area within the Madagascar Protected Area System. Our cross-seasonal surveys of four sites revealed the presence of 124 bird species, including 56 Malagasy endemics and 8 species endemic to the southern ecoregion. Bird diversity at each site ranges from 53 to 99, these differences being largely explained by differences in wetland bird diversity. Rates of national and regional (Madagascar and the western Indian Ocean islands) endemism are highest among forest-dependent species (77.7/98.1%), and lowest among wetland species (9.8/12.2%). 50 of our records represent new records for the site, and 17 represent range extensions, of which 9 are of wetland species. Literature reviews reveal records of a further six species, giving PK32-Ranobe the most diverse avifauna of any site in the south-west of Madagascar. Based on our survey results, we strongly support the establishment of a protected area that encompasses the full range of vegetation types within the site, and recommend that the wetlands of Ranobe and Belalanda, the gallery forests of the Fiherenana and Manombo river systems and the transitional forest at Ranobe receive the highest priority in protected area zoning and management planning.

**Résumé:** La zone de PK32-Ranobe (Région d'Atsimo Andrefana), une nouvelle aire protégée proposée dans le Système des Aires Protégées de Madagascar, a été l'objet d'un premier inventaire ornithologique compréhensif. Nos prospections dans quatre sites en toutes saisons ont révélé la présence de 124 espèces d'oiseaux, incluant 56 espèces endémiques à Madagascar et 8 espèces endémiques à l'écorégion du Sud. La diversité des oiseaux varie de 53 à 99 entre les sites ; cette variation peut être surtout expliquée par les différences en diversité d'oiseaux aquatiques. Le taux d'endémisme au niveau national et régional (Madagascar et les îles de l'Ouest de l'Océan Indien) est plus élevé parmi les espèces forestières (77,7/98,1%), et plus bas parmi les espèces aquatiques (9,8/12,2%). 50 des espèces inventoriées représentent les premières observations dans la zone, et 17 représentent des extensions de leurs aires de répartition connues, dont 9 sont des oiseaux aquatiques. Une revue de la littérature indique encore six espèces connues de la zone, rendant l'avifaune de PK32-Ranobe la plus diverse dans le Sud-Ouest de Madagascar. A partir de nos résultats, nous soutenons la mise en place d'une aire protégée qui intègre tous les formations végétales de la zone, et nous recommandons que les zones humides de Ranobe et de Belalanda, les forêts galeries des fleuves Fiherenana et Manombo, et la forêt de transition de Ranobe soient prioritaires dans l'aménagement et la planification de la gestion de l'aire protégée.

## Introduction

Madagascar's avifauna is characterised by relatively low species diversity, but elevated levels of species and higher taxon endemism. A total of 283 species have been recorded, of which 209 are regular breeders (Hawkins & Goodman 2003). 116 of these species are recognised as endemic (Hawkins and Goodman 2003, Sinclair and

Langrand 2003), representing 40% of all species and 55.5% of breeding species, giving Madagascar the highest proportion of endemic species of any large country in the world. Three families are endemic (the Mesitornithidae, Brachypteraciidae and Bernieridae), while the Leptosomatidae and Vangidae are near-endemic, both having a single species occurring on the nearby Comoros islands. In addition the Couinae and Philepittinae are endemic subfamilies.

The spiny forest ecoregion of southern and south-western Madagascar is one of the most biologically rich in the country, characterised by high species diversity and levels of local endemism. The endemic flora of the region surpasses 1000 species, and approximately 53% of indigenous plant species are locally endemic, with a further 36% of species endemic to Madagascar (Phillipson 1996). High levels of local endemism are also found amongst the reptiles (Glaw and Vences 2007) and birds – the ecoregion has been classified as an Endemic Bird Area (EBA) on the basis of 10 locally endemic species (Stattersfield *et al.* 1998).

The ecoregion is recognised as a high conservation priority for Madagascar (WWF 2002), and suffers the fastest rates of forest loss in the country (Conservation International *et al.* 2007). It was considered under-represented in terms of formal protection (Collar and Stuart 1985, Du Puy and Moat 1996, Seddon *et al.* 2000, Fenn 2003) prior to the expansion of Madagascar's Protected Area System (Système des Aires Protégées de Madagascar, SAPM) which was launched in 2003 (the 'Durban Vision', see Mittermeier *et al.* 2005, GoM 2007). A number of new protected areas (PA) are now being established within the ecoregion under the Durban Vision initiative, including that of PK32-Ranobe, our study site.

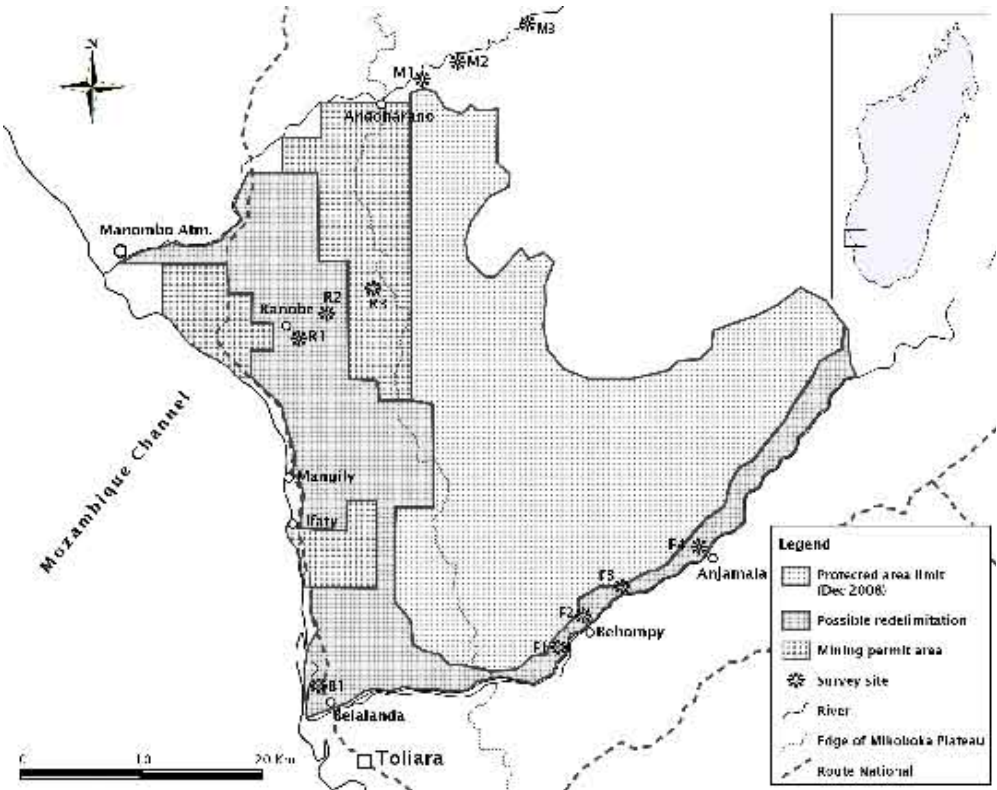
This paper presents the results of a multi-season survey carried out in the proposed PK32-Ranobe protected area as part of the Frontier Madagascar Forest Research Programme between August 2002 and December 2004. The objective of the research was to supplement existing data with an intensive survey of the full range of major habitat types within the proposed protected area in order to compile up-to-date baseline data with which to inform conservation prioritisation, planning and management. Inventories were compiled for birds, reptiles, amphibians, mammals, plants and select invertebrate taxa; for a full report of research results for non-bird taxa, see Thomas *et al.* (2005).

## Study site

The PK32-Ranobe site, which forms part of the South Mangoky centre of micro-endemism (Wilmé *et al.* 2006), has been long been recognised as a conservation priority area (Domergue 1983, Nicoll and Langrand 1989, Raxworthy 1995, Ganzhorn *et al.* 1997, ZICOMA, 1999, Seddon *et al.* 2000), and since 2006 has been the focus of an initiative to establish an IUCN Category V community co-managed protected area within Madagascar's expanded protected areas system (WWF 2007). The proposed protected area lies to the north of the regional capital of Toliara (Tuléar) on Madagascar's south-west coast, stretching between the Fiherenana River to the south and the Manombo River to the north. It is bordered to the west by the Mozambique Channel, and extends to the eastern edge of the Tertiary limestone Mikoboka Plateau

(see map, Figure 1). The climate is sub-arid, receiving 100-1300 mm of rainfall per annum (Seddon *et al.* 2000). The site is characterised by high habitat heterogeneity, influenced by heterogeneous geology (Du Puy and Moat 1996) and north-south and east-west gradients in rainfall (Rakotomalaza and McKnight 2006). Six distinct terrestrial habitat types can be recognised within an area of approximately 300, 000 ha (WWF 2007): littoral thicket on coastal white sands, spiny thicket on red sands rich in sesquioxides, spiny thicket on limestone, gallery forest, a transitional forest between the spiny thicket of the southern domain and dense dry forest of the western domain, and freshwater and brackish wetlands.

Two published inventories exist of the birds of the PK32-Ranobe area, those of Domergue (1983) and Nicoll & Langrand (1989). 79 species were recorded by these authors, but their surveys were concentrated in relatively small areas and several sub-regions and major habitat types remained un-surveyed. We aimed to supplement these data with intensive wet and dry season surveys of four areas (study locations) within the proposed protected area. 1–4 sites were surveyed at each study location, the details of which are shown in Table 1 below.



**Fig. 1** Map of the survey area



**Table 1** Details of survey locations

Study Location	Survey site	Habitat type	Latitude	Longitude	Dates surveyed	Total survey period (days)
Fihiranana River valley	F1	Riparian forest, spiny thicket on limestone	S23° 14' 10.0"	E043° 52' 14.3"	11.08.02-28.08.02, 12.10.02-10.12.02, 05.07.03-28.08.03	135
	F2	Spiny thicket on limestone	S23° 13' 51.0"	E043° 51' 36.6"		
	F3	Riparian forest, transitional forest	S23° 12' 44.2"	E043° 53' 36.1"		
	F4	Riparian forest, transitional forest	S23° 10' 40.2"	E043° 57' 44.8"		
	B1	Brackish lakes and reed beds	S23° 17' 24.3"	E043° 38' 53.1"	19.05.03-29.05.03, 02.11.03-06.11.03, 20.07.04-27.07.04	24
Ranobe Lake and forests	R1	Freshwater lake and reed beds, transitional forest	S23° 02' 24.6"	E043° 36' 34.2"	14.01.03-28.03.03, 13.04.03-04.06.03, 14.10.03-08.12.03, 16.01.04-08.03.04, 05.07.04-29.08.04	292
	R2	Transitional forest, spiny thicket on red sand	S23° 02' 05.5"	E043° 37' 52.1"		
	R3	Anthropogenic grassland, spiny thicket on limestone	S23° 01' 47.9"	E043° 41' 38.2"		
	M1	Riparian forest	S22° 48' 21.6"	E043° 44' 02.4"	17.01.04-31.01.04, 21.02.04-05.03.04, 05.04.04-31.05.04, 07.07.04-16.07.04, 11.10.04-04.12.04	151
Manombo River valley	M2	Riparian forest, transitional forest	S22° 48' 16.0"	E043° 45' 38.7"		
	M3	Riparian forest, transitional forest, spiny thicket on limestone	S22° 47' 10.0"	E043° 48' 19.0"		

## Methodology

We employed two methods to compile a bird inventory at each of the four study sites; timed observation walks and casual observations (Bibby *et al.* 1998)

### *Timed observation walks*

Walks were carried out at times of peak bird activity, between 05:00 and 08:30, and between 16:00 and 18:00. All habitat types occurring within the study sites were surveyed in approximate proportion to the extent of their occurrence.

### *Casual observations*

In addition to formal data collection, all visual bird sightings around base camps or elsewhere were recorded. Such observations are useful to record species that may otherwise go unrecorded using the formal method, such as nocturnal or cryptic species or those occurring at low density.

For taxonomy and nomenclature we generally follow Hawkins and Goodman (2003). This review, however, treats as subspecies a number of taxa that have subsequently been demonstrated to merit full specific status, all of which are species with closely-related sister taxa occurring on the Comoros or Aldabra islands. For these species we follow the revisions accepted by Sinclair and Langrand (2003). The elevation of these taxa to full species raises the number of Madagascar endemics by 9 from the figures given in Hawkins and Goodman (2003); the figures for national endemism quoted within this paper thus represent our own calculations incorporating the new revisions.

## Results

We recorded a total of 124 species at the four survey locations, representing 99 genera and 51 families (see Table 3 for complete list with details of recorded locations, habitat utilisation and endemism). 116 of these species breed in Madagascar, representing 55.5% of all Madagascar's breeding species. 56 endemic species were recorded (48.3% of Madagascar's endemic species) while a further 17 species are endemic to the region (defined as Madagascar, the Comoros, Seychelles and Mascarene island groups).

Table 4 below provides rates of national and regional endemism for bird species recorded during this survey, divided by broad habitat categories. Of the 124 species we recorded, 56 (45.2%) are endemic to Madagascar, and a further 17 (13.7%) are endemic to the Madagascar region, giving a total rate of regional endemism of 58.9%. Endemism amongst obligate wetland species is comparatively low, with 9.8% of recorded species endemic to Madagascar and 12.2% endemic to Madagascar and the region. Removing these wetland species from the analysis gives figures of 61.0% national and 80.5%

**Table 2** Summary of survey effort

Effort unit	Fiherenana	Belalanda	Ranobe	Manombo	Total
No. of observation walks	61	19	117	57	254
No. of observation hours	116	46.5	225	100	487.5

**Table 3** Fiherenana-Manombo Complex bird species list

<b>Latin name</b>	<b>English name</b>	<b>Authority</b>	<b>Fiherenana</b>	<b>Belanda</b>	<b>Ranobe</b>	<b>Manombo</b>	<b>Habitat</b>	<b>Status</b>
<i>Tachybaptus ruficollis</i>	little grebe	Pallas, 1764		X	X		W	
<i>Phalacrocorax africanus</i>	reed cormorant	Gmelin, 1789	X				W	
<i>Ixobrychus minutus</i>	little bittern	Linnaeus, 1766		X	X		W	
<i>Nycticorax nycticorax</i>	black-crowned night heron	Linnaeus, 1758	X		X		W	
<i>Ardeola ralloides</i>	squacco heron	Scopoli, 1769	X	X	X	X	W	
<i>Bubulcus ibis</i>	cattle egret	Linnaeus, 1758	X	X	X	X	W, O	
<i>Butorides striatus</i>	green-backed heron	Linnaeus, 1758	X	X	X		W	
<i>Egretta ardesiaca</i>	black egret	Wagler, 1827		X	X		W	
<i>Egretta dimorpha</i>	dimorphic egret	Hartert, 1924	X	X	X	X	W	
<i>Egretta alba</i>	great egret	Linnaeus, 1758	X	X	X		W	
<i>Ardea purpurea</i>	purple heron	Linnaeus, 1766	X		X	X	W	
<i>Ardea cinerea</i>	grey heron	Linnaeus, 1758	X		X		W	
<i>Ardea humbloti</i>	Humboldt's heron	Milne Edwards & Grandidier, 1885	X				W	E
<i>Scopus umbretta</i>	Hamerkop	Gmelin, 1789	X			X	W	
<i>Anastomus lamelligerus</i>	African openbill stork	Temminck, 1823			X		W	
<i>Lophotibis cristata</i>	Madagascar crested ibis	Boddaert, 1793				X	T	E
<i>Phoenicopterus ruber</i>	greater flamingo	Linnaeus, 1758		X			W	
<i>Dendrocygna viduata</i>	white-faced whistling duck	Linnaeus, 1766		X	X		W	
<i>Sarkidiornis melanotos</i>	knob-billed duck	Pennant, 1769	X		X		W	
<i>Nettion auritus</i>	African pygmy goose	Boddaert, 1783			X		W	
<i>Anas erythrorhynchos</i>	red-billed teal	Gmelin, 1789		X	X		W	
<i>Anas hottentota</i>	Hottentot teal	Eyton, 1838		X	X		W	
<i>Thalassornis leuconotus</i>	white-backed duck	Eyton, 1838			X		W	
<i>Aviceda madagascariensis</i>	Madagascar cuckoo-hawk	Smith, 1834				X	T	E
<i>Mihvus aegyptius</i>	yellow-billed kite	Gmelin, 1788	X		X	X	REF, O	

Latin name	English name	Authority	Fiherenana	Belalandia	Ranobe	Manombo	Habitat	Status
<i>Polyboroides radiatus</i>	Madagascar harrier-hawk	Scopoli, 1786	X		X	X	RF,T	E
<i>Accipiter madagascariensis</i>	Madagascar sparrowhawk	Smith, 1834				X	RF	E
<i>Accipiter francesii</i>	France's sparrowhawk	Smith, 1834	X		X	X	RF, T	RE
<i>Buteo brachypterus</i>	Madagascar buzzard	Hartlaub, 1860	X		X	X	RF, T, O	E
<i>Falco newtoni</i>	Madagascar kestrel	Gurney, 1863	X	X	X	X	RF,S,T,O	RE
<i>Falco zoniiventris</i>	banded kestrel	Peters, 1854	X		X		O	E
<i>Falco concolor</i>	sooty falcon	Temminck, 1825			X		O	
<i>Falco peregrinus</i>	peregrine falcon	Tunstall, 1771	X				S	
<i>Margaroperdix madagarensis</i>	Madagascar partridge	Scopoli, 1786	X		X	X	RF,T,O	E
<i>Coturnix coturnix</i>	common quail	Linnaeus, 1758			X		O	
<i>Numida meleagris</i>	helmeted guineafowl	Linnaeus, 1758	X		X	X	O	I?
<i>Monias benschi</i>	subdesert mesite	Oustalet & Grandidier, 1903			X		S	E
<i>Turnix nigricollis</i>	Madagascar buttonquail	Gmelin, 1789	X		X	X	RF,S,T	E
<i>Dryolimnas cuvieri</i>	white-throated rail	Pucheran, 1845			X		W	RE
<i>Porzana pusilla</i>	Baillon's crane	Pallas, 1776		X			W	
<i>Gallinula chloropus</i>	common moorhen	Linnaeus, 1758		X	X		W	
<i>Porphyrio porphyrio</i>	purple swamphen	Linnaeus, 1758		X			W	
<i>Fulica cristata</i>	red-knobbed coot	Gmelin, 1789		X	X		W	
<i>Rostratula benghalensis</i>	greater painted snipe	Linnaeus, 1758	X		X		W	
<i>Himantopus himantopus</i>	black-winged stilt	Linnaeus, 1758		X	X		W	
<i>Pluvialis squatarola</i>	grey plover	Linnaeus, 1758			X		W	
<i>Charadrius hiaticula</i>	ringed plover	Linnaeus, 1758		X	X		W	
<i>Charadrius thoracicus</i>	Madagascar plover	Richmond, 1896		X	X		W	E
<i>Charadrius pecuarius</i>	Kittlitz's plover	Temminck, 1823	X	X	X		W	
<i>Charadrius tricollaris</i>	three-banded plover	Viellot, 1818	X	X	X		W	
<i>Tringa stagnatilis</i>	marsh sandpiper	Bechstein, 1803		X			W	

<i>Tringa nebularia</i>	common greenshank	Gunnerus, 1767	X	X	X	W	
<i>Actitis hypoleucos</i>	common sandpiper	Linnaeus, 1758	X	X	X	W	
<i>Calidris ferruginea</i>	curlew sandpiper	Pontoppidan, 1763		X		W	
<i>Sterna caspia</i>	Caspian tern	Pallas, 1770	X	X		W	
<i>Pterocles personatus</i>	Madagascar sandgrouse	Gould, 1843			X	O	E
<i>Sreptopelia picturata</i>	Madagascar turtle dove	Temminck, 1813	X	X	X	RF,S,T	RE
<i>Oena capensis</i>	Namaqua dove	Linnaeus, 1766	X	X	X	O,S	
<i>Treron australis</i>	Madagascar green pigeon	Linnaeus, 1771	X	X	X	RF,T	RE
<i>Alactroenas madagascariensis</i>	Madagascar blue pigeon	Linnaeus, 1766	X			RF	E
<i>Coracopsis vasa</i>	greater vasa parrot	Shaw, 1811	X		X	All	RE
<i>Coracopsis nigra</i>	lesser vasa parrot	Linnaeus, 1758	X		X	All	RE
<i>Agapornis cana</i>	grey-headed lovebird	Gmelin, 1788	X	X	X	RF, T, O	E
<i>Cuculus rochii</i>	Madagascar lesser cuckoo	Hartlaub, 1862	X	X	X	RF,T,S	
<i>Coua gigas</i>	giant coua	Boddaert, 1783	X		X	RF, T	E
<i>Coua coquerelli</i>	Coquerel's coua	Grandidier, 1867	X		X	RF, T	E
<i>Coua cursor</i>	running coua	Grandidier, 1867			X	S	E
<i>Coua ruficeps olivaceiceps</i>	green-capped coua	Sharpe, 1875		X	X	RF,T,S	E
<i>Coua cristata</i>	crested coua	Linnaeus, 1766	X		X	RF, T, S	E
<i>Centropus toulou</i>	Madagascar coucal	Müller, 1776	X	X	X	All	RE
<i>Tyto alba</i>	barn owl	Scopoli, 1769			X	T	
<i>Otus madagascariensis</i>	western scops owl	Pucheran, 1849	X	X	X	RF	E
<i>Ninox supercilialis</i>	white-browed owl	Viellot, 1823	X		X	RF	E
<i>Asio madagascariensis</i>	Madagascar long-eared owl	Smith, 1834			X	RF, T	E
<i>Caprimulgus madagascariensis</i>	Madagascar nightjar	Sganzin, 1840	X	X	X	RF, O	RE
<i>Zoonavena grandidieri</i>	Madagascar spine-tailed swift	Verreaux, 1867	X		X	O	RE
<i>Cypsiurus parvus</i>	African palm swift	Lichtenstein, 1823		X	X	O	
<i>Apus melba</i>	alpine swift	Linnaeus, 1758		X	X	O	

Latin name	English name	Authority	Fiherenana	Belalanda	Ranobe	Manombo	Habitat	Status
<i>Apus barbatus</i>	African black swift	Sclater, 1865			X		S, RF	
<i>Alcedo vinisioides</i>	Madagascar malachite kingfisher	Eydoux & Gervais, 1836	X	X	X	X	RF, W	RE
<i>Ispidina madagascariensis</i>	Madagascar pygmy kingfisher	Linnaeus, 1766	X			X	RF,T	E
<i>Merops superciliosus</i>	Madagascar bee-eater	Linnaeus, 1766	X	X	X	X	RF,S,T,O	
<i>Eurystomus glaucurus</i>	broad-billed roller	Müller, 1776	X		X	X	RF,T,O	
<i>Uratelornis chimamera</i>	long-tailed ground-roller	Rothschild, 1895			X		S	E
<i>Leptosomus discolor</i>	Madagascar cuckoo-roller	Hermann, 1783			X	X	RF,T	RE
<i>Upupa marginata</i>	Madagascar hoopoe	Cabanis & Heine, 1860	X	X	X	X	RF, T	E
<i>Mirafra hova</i>	Madagascar bush lark	1860 Hartlaub, 1860	X	X	X	X	O	E
<i>Phedina borbonica</i>	Mascarene martin	Gmelin, 1789		X	X		O	RE
<i>Hirundo rustica</i>	barn swallow	Linnaeus, 1758			X		O	
<i>Motacilla flaviventris</i>	Madagascar wagtail	Hartlaub, 1860			X	X	O	E
<i>Coracina cinerea</i>	ashy cuckoo-shrike	Müller, 1776	X		X	X	RF, S	RE
<i>Bernieria madagascariensis</i>	long-billed tetraka	Gmelin, 1789	X			X	RF, T	E
<i>Hypsipetes madagascariensis</i>	Madagascar bulbul	Müller, 1776	X	X	X	X	All	RE
<i>Copsychus albospectularis</i>	Madagascar magpie robin	Eydoux & Gervais, 1836	X		X	X	All	E
<i>Monticola inermis</i>	littoral rock thrush	Hartlaub, 1860		X			O	E
<i>Monticola sharpei</i>	Forest rock thrush	Gray, 1871	X				RF	E
<i>Acrocephalus newtoni</i>	Madagascar swamp warbler	Hartlaub, 1863		X	X		W	E
<i>Nesillas lantzi</i>	subdesert brush warbler	Grandidier, 1867	X	X	X		S,RF	E
<i>Nesillas typica</i>	Madagascar brush warbler	Hartlaub, 1866	X			X	RF,T	RE
<i>Thamnomnis chloropetoides</i>	Thamnomnis warbler	Grandidier, 1867	X		X		S	E
<i>Cisticola cherina</i>	Madagascar cisticola	Smith, 1843	X	X	X	X	O	E
<i>Newtonia brunneicauda</i>	common newtonia	Newton, 1863	X		X	X	All	E
<i>Newtonia archboldi</i>	Archbold's newtonia	Delacour & Berlioz, 1931			X	X	RF,S,T	E

<i>Neomixis tenella</i>	common jery	Hartlaub, 1866	X	X	X	All	E
<i>Neomixis striatigula</i>	stripe-throated jery	Sharpe, 1881	X	X	X	RF,S,T	E
<i>Terpsiphone mutata</i>	Madagascar paradise flycatcher	Linnaeus, 1766	X		X	RF,T	RE
<i>Nectarinia souimanga</i>	souimanga sunbird	Gmelin, 1788	X	X	X	All	RE
<i>Nectarinia notata</i>	Madagascar green sunbird	Linnaeus, 1766	X	X	X	RF,O	RE
<i>Zosterops maderaspatana</i>	Madagascar white-eye	Linnaeus, 1766	X	X	X	RF,T	RE
<i>Calicalicus madagascariensis</i>	red-tailed vanga	Linnaeus, 1766	X	X	X	RF, T, S	E
<i>Schetba rufa</i>	rufous vanga	Linnaeus, 1766	X		X	RF,T	E
<i>Vanga curvirostris</i>	hook-billed vanga	Linnaeus, 1766	X		X	RF,T	E
<i>Xenopirostris xenopirostris</i>	Lafresnaye's vanga	Lafresnaye, 1850	X	X	X	RF,T,S	E
<i>Falcula palliata</i>	sickle-billed vanga	Geoffroy Saint Hilaire, 1836	X	X	X	RF,S	E
<i>Leptopternis viridis</i>	white-headed vanga	Müller, 1776	X	X	X	RF,T,S	E
<i>Leptopternis chabert</i>	Chabert's vanga	Müller, 1776	X	X	X	RF,S,T	E
<i>Cyanolanius madagascarinus</i>	blue vanga	Linnaeus, 1766	X	X	X	RF,T	RE
<i>Tylas eduardi albigularis</i>	tylas vanga	Hartlaub, 1877	X		X	RF,S	E
<i>Dicrurus forficatus</i>	crested drongo	Linnaeus, 1766	X	X	X	All	RE
<i>Corvus albus</i>	pie'd crow	Müller, 1776	X	X	X	O	
<i>Acridotheres tristis</i>	common myna	Linnaeus, 1766	X	X	X	O	I
<i>Ploceus sakalava</i>	Sakalava weaver	Hartlaub, 1861	X		X	All	E
<i>Foudia madagascariensis</i>	Madagascar red fody	Linnaeus, 1766	X	X	X	All	E
<i>Lonchura nana</i>	Madagascar manikin	Pucheran, 1845	X	X	X	O	E
<b>Total No. of species per site</b>			<b>81</b>	<b>53</b>	<b>99</b>	<b>72</b>	
<b>Species total PK32 Ranobe</b>			<b>124</b>				

Habitat codes: RF=riparian forest, S=spiny thicket, T=transitional forest, O=open, W=water (open water, shoreline, reed bed), All=associated with all terrestrial habitats

Status codes: E=Endemic to Madagascar, RE=Endemic to Madagascar region (Madagascar and western Indian Ocean islands), I=Introduced



regional endemism for all terrestrial species. Endemism rates are highest amongst recorded forest-dependent species, of which 77.7% are endemic to Madagascar and 98.1% are endemic to the region. The record of *Alectroenas madagascariensis* is excluded from the above analysis as it is considered a vagrant.

*Analysis by sites*

Figure 2 shows species-accumulation curves (cumulative species richness as a function of increasing research effort) for the four survey locations. For Belalanda, Manombo and Ranobe these curves reach a plateau, indicating that further survey effort would be expected to generate few additional records, and therefore that our surveys recorded all or almost all of the species present at the site. The species-accumulation curve for the Fiherenana site shows a distinct shoulder at 70 hours, marking a seasonal transition between the two survey periods at this location. That the Fiherenana curve does not reach a clear plateau indicates that further research effort is required at this site.

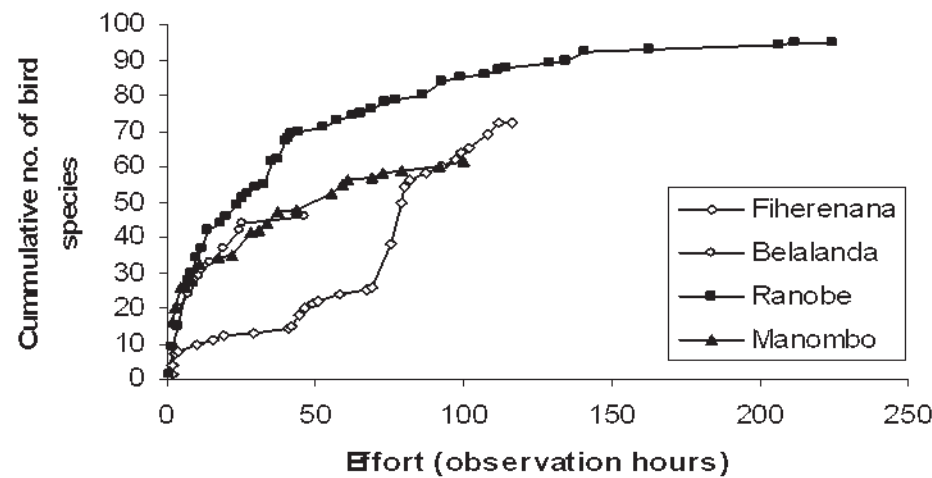


Fig. 2 Species accumulation curves for survey sites

Table 4 Endemism rates by habitat

Habitat	Total No. of species	Number endemics	% endemics	No. regional endemics	% regional endemics	Total % regional endemics
All species	124	50	40.3	22	17.7	58.1
All terrestrial	83	47	56.6	20	24.1	80.7
Obligate wetland	41	3	7.3	2	4.9	12.1
Obligate forest	52	37	71.2	14	26.9	98.1

The number of species recorded per site ranges from 53 (Belalanda) to 99 (Ranobe), see Table 5 below. While research effort was considerably lower at Belalanda than at other sites (see Table 2), the species-accumulation curves above indicate that the comparatively low species diversity at this site is not an artefact of this reduced research effort. Rather, the low diversity at Belalanda is related to the lack of un-degraded thicket or forest habitats around the wetland complex (indeed, only 15 species of non-wetland bird were recorded there). The differences in overall bird diversity between the Fiherenana, Manombo and Ranobe sites are largely explained by differences in wetland bird diversity, the sites harbouring remarkably similar numbers of non-wetland species (62, 67 and 64 respectively). When only forest or thicket dependent species are analysed, the diversity at these sites is even more similar, with 43, 43 and 44 species respectively.

Of the 124 species recorded, only 28 (22.6%) were recorded at all four survey locations, while 30 species (24.2%) were only recorded at one site. These figures are indicative of the habitat heterogeneity of the survey area, and illustrate the importance of including all survey locations in the protected area to ensure full representation of the region's bird diversity within its limits. 17 species were recorded only along the Fiherenana and Manombo river systems, of which 12 (including regionally restricted species such as *Lophotibis cristata*, *Aviceda madagascariensis*, *Accipiter madagascariensis*, *Coua gigas*, *Coua coquereli*, *Ninox superciliaris*, *Ispidina madagascariensis*, *Bernieria madagascariensis* and *Schetba rufa*) were restricted to gallery and transitional forests.

## Discussion

### Literature review

Comparison of the bird inventories compiled during our survey with published records from PK32-Ranobe (Domergue 1983, Nicoll and Langrand 1989) reveals that 50 of our species records represent new records for the site. The large number of new records is primarily due to the increased coverage in both time and space of our survey; 28 of these records, for example, are of wetland species, and while Nicoll and Langrand (1989) did briefly conduct surveys at Lac Ranobe, they did not survey the brackish wetlands of Belalanda or the Manombo and Fiherenana rivers. Of the other species not recorded previously, many are cryptic or occur at naturally low densities (eg *Aviceda madagascariensis*, *Tylas eduardi*), occur in habitats not surveyed by the authors (eg *Monticola imerinus* which is restricted to littoral thicket), are vagrants or rare visitors to the region (eg *Hirundo rustica*, *Alectroenas madagascariensis*) or have undergone taxonomic revision (eg *Nesillas lantzii*).

**Table 5** Habitat breakdown by site

	Fiherenana	Belalanda	Ranobe	Manombo
All species	81	53	99	72
Wetland species	19	28	32	8
All terrestrial	62	15	67	64
Forest species	43	12	43	44

New records include *Acridotheres tristis*, a species introduced into the east of the country in 1875 as a biological control agent against locusts (Hawkins & Goodman, 2003). That the species was not recorded in the area in 1989 is indicative of the continued westward and southward expansion of the species since the initial colonisation event. Indeed, the distribution maps produced in Langrand (1990) indicate that the species, by that point well established across the south, had not yet expanded up the west coast as far as Toliara. The presence of the species at all four study locations may also be indicative of an increase in habitat conversion and degradation in the surveyed areas, as the species is not able to colonise primary forest habitats (Langrand 1990).

Six species were recorded in previous surveys that we did not record; *Tachybaptus pelzelinii*, *Coturnix delagorguei*, *Charadrius marginatus*, *Calidris minuta*, *Asio capensis*, and *Saxicola torquata*. Of these, *Charadrius marginatus* is generally a coastal species and *Calidris minuta* is an uncommon migrant (Langrand, 1990); neither can therefore be considered an important component of the avifauna of the protected area. *Coturnix delagorguei* is a species whose behaviour in Africa is characterised by mass unexplained migrations (Langrand 1990). The absence of this species within the study area during the survey period may therefore be attributable to such movements. While the lack of records of *Saxicola torquata* and *Asio capensis* within the present study is harder to explain, the apparent disappearance from the study area of *Tachybaptus pelzelinii* may be indicative of a worrying national population trend for this species. *Tachybaptus pelzelinii* is a globally threatened (Vulnerable: BirdLife International 2008a) endemic species whose distribution has contracted and population decreased due to competition with the little grebe, *Tachybaptus ruficollis* (Langrand, 1990). The latter species, distributed in Europe, Asia, Oceania and Africa, and represented in Madagascar by the subspecies *T. r. capensis*, is a relatively recent arrival in Madagascar, with the first records originating from the 1920s (Young, 2003). Its expansion since then has been rapid, aided by the introduction of herbivorous fish (*Tilapia* spp.) that limit the growth of aquatic vegetation and thereby alter the structure and ecology of water bodies to the detriment of the endemic *Tachybaptus* species (Langrand, 1990). That *T. pelzelinii* was not recorded during the present survey may indicate its local extinction in the Toliara area, as few other suitable wetlands exist in the region.

#### *Comparison with other areas in the South-west*

In addition to our surveys, avifaunal surveys have been conducted in the three other major protected areas of south-western of Madagascar – the Mikea Forest National Park (Raselimanana and Goodman, 2004), Tsimanampetsotsa National Park (Goodman *et al.*, 2002) and the Amoron'i Onilahy protected area (Emmett *et al.* 2003). The inventory of the Mikea Forest, having been compiled from 21 days of survey effort (that did not include surveys of wetlands), cannot be considered complete. In comparison, the Amoron'i Onilahy inventory took place over 15 months and the Tsimanampetsotsa inventory, while based on only 14 days of survey, also included a literature review of historical bird records from the area. The inventory of the Mikea Forest is therefore not strictly comparable with those of the other three sites.

Comparison of these inventories reveals that PK32-Ranobe, with 130 species,

has significantly higher bird diversity than Tsimanampetsotsa (104), Amoron'i Onilahy (79) or the Mikea Forest (63). 18 species recorded in our surveys of PK32-Ranobe have not been recorded in the region's other protected areas, while 10 species have been recorded elsewhere but not at PK32-Ranobe (see Table 6). Note that for the purposes of the present analysis, the PK32-Ranobe inventory also includes a literature review

**Table 6** Species records unique to one of the region's protected areas

Species	Fiherenana-Manombo Complex	Tsimanampetsotsa	Mikea Forest	Amoron'i Onilahy
<i>Tachybaptus ruficollis</i>	X			
<i>Phalacrocorax africanus</i>	X			
<i>Ixobrychus minutus</i>	X			
<i>Ardeola ralloides</i>	X			
<i>Ardeola idea</i>				X
<i>Egretta ardesiaca</i>	X			
<i>Anastomus lamelligerus</i>	X			
<i>Mycteria ibis</i>		X		
<i>Phoenicopterus minor</i>		X		
<i>Nettapus auritus</i>	X			
<i>Thalassornis leuconotus</i>	X			
<i>Accipiter henstii</i>		X		
<i>Falco eleanorae</i>		X	X	
<i>Porzana pusilla</i>	X			
<i>Porphyrio porphyrio</i>	X			
<i>Rostratula benghalensis</i>	X			
<i>Charadrius leschenaulti</i>		X		
<i>Calidris ferruginea</i>	X			
<i>Numenius arquata</i>		X		
<i>Calidris minuta</i>	X			
<i>Larus dominicanus</i>		X		
<i>Alectroenas madagascariensis</i>	X			
<i>Coua verreauxi</i>		X		
<i>Ispidina madagascariensis</i>	X			
<i>Hirundo rustica</i>	X			
<i>Monticola sharpei bensoni</i>	X			
<i>Calicalicus rufocarpalis</i>		X		
<i>Cyanolanius madagascariensis</i>	X			
<i>Xenopirostris damii</i>	X			
<b>Number of species restricted to site</b>	<b>19</b>	<b>8</b>	<b>0</b>	<b>1</b>

of historical records (Domergue 1983, Nicoll and Langrand 1989). Of the 18 species restricted to PK32-Ranobe, 13 are wetland species, emphasising the importance of the Ranobe and Belalanda wetlands for the wetland bird diversity of south-western Madagascar. Of the five remaining species not recorded in the region's other protected areas, two are vagrants or rare migrants (*Alectroenas madagascariensis*, *Hirundo rustica*), one represents a possible range extension (*Monticola sharpei bensoni*), and two represent forest-dependant endemics (*Ispidina madagascariensis*, *Cyanolanius madagascariensis*).

### *Range extensions*

Based on the species distribution maps published in Langrand (1990), 19 of the species we observed were recorded outside of their known ranges. Of these, *Alectroenas madagascariensis* is a species restricted to the humid forests of eastern Madagascar, and is therefore considered to be a vagrant rather than a genuine range extension, while *Hirundo rustica* is a rare migrant to Madagascar, and therefore without a range as such. Records of the remaining species (of which nine are obligate wetland species generally absent from the arid south, while eight are terrestrial endemics) can be considered to represent genuine range extensions. For all nine wetland species (*Ixobrychus minutus*, *Nycticorax nycticorax*, *Ardeola ralloides*, *Egretta ardesiaca*, *Egretta alba*, *Ardea purpurea*, *Scopus umbretta*, *Anastomus lamelligerus* and *Porphyrio porphyrio*), Landrand's (1990) maps show the western coastal distributions extending as far south as the Mangoky River and Lac Ihotry, approximately 150 km to the north of Lac Ranobe. Our findings therefore further highlight the importance of the Belalanda and particularly the Ranobe wetlands in harbouring the southernmost populations in western Madagascar of a number of wetland species.

Of the non-wetland species that represent range extensions, six (*Margaroperdix madagascariensis*, *Coua coquereli*, *Ispidina madagascariensis*, *Calicalicus madagascariensis*, *Schetba rufa* and *Cyanolanius madagascariensis*) are widespread in the western forests of Madagascar, but were not considered by Landrand (1990) to occur south of the Mangoky River. The exception is *Tylas eduardi*, a species widespread in the humid eastern forests whose western subspecies (*T.e. albigularis*) is little known and considered by some authors to merit elevation to species (eg Sinclair and Landrand 2003). *Monticola sharpei bensoni* (a taxon previously considered a full species (Hawkins and Goodman 2003)), was considered by Langrand (1990) to be a breeding endemic to the Isalo massif over-wintering in the forests of Zombitse-Vohibasia and along the Mangoky. BirdLife International (2008b) assert that the subspecies has a relatively broad range in south-central and south-western Madagascar, but our records from the gallery forests of the Fiherenana River may nevertheless represent a new over-wintering site for the taxon.

### *Species of conservation concern*

Table 7 lists the 12 species we consider to be species of conservation concern, based on either local endemism or inclusion in the IUCN Red List of Threatened Species. Stattersfield *et al.* (1998) classify the region as the South Malagasy Spiny

Forests Endemic Bird Area (EBA) based on the presence of ten species whose global distribution is wholly restricted to the area. Eight of these species were recorded in this survey.

The two most important species, based on restricted distribution and taxonomic importance, are the long-tailed ground roller (*Uratelornis chimaera*) and the subdesert mesite (*Monias benschi*). Both of these species represent monotypic genera within endemic families (the Brachypteracidae and Mesitornithidae respectively), and as such contribute greatly to the higher taxonomic diversity of Madagascar's avifauna. Both species are restricted to the Mikea Forest, a narrow coastal strip approximately 30-70 km wide and 200 km long of which PK32-Ranobe represents the southernmost part (Hawkins and Seddon 2003, Langrand 2003). Based on the importance of these two species ZICOMA (1999) declared that in terms of conserving the 'genetic diversity of birds, the Mikea Forest will be considered a supreme priority in Africa'. Both species are classified by the IUCN as Vulnerable (IUCN 2007) on the basis of their narrow geographic ranges and small, declining populations, although Tobias and Seddon (2002) assert that *Monias benschi* does not merit this classification according to IUCN criteria, and recommend downgrading the species. Of the other locally endemic species recorded in our survey, all are common and widespread across the south and classified as Least Concern (IUCN 2007).

**Table 7** Species of conservation concern

Species of Conservation Concern	Locally Endemic	Red List Status	Habitat	Sites recorded
<i>Monias benschi</i>	*	VU	S	Ranobe
<i>Coua cursor</i>	*		S	Ranobe
<i>Uratelornis chimaera</i>	*	VU	S	Ranobe
<i>Xenopirostris xenopirostris</i>	*		RF,T,S	Fiherenana, Ranobe, Manombo
<i>Monticola imerinus</i>	*		O	Belanda
<i>Nesillas lantzii</i>	*		S, RF	Fiherenana, Belanda, Ranobe
<i>Thamnornis chloropetoides</i>	*		S	Fiherenana, Ranobe
<i>Newtonia archboldi</i>	*		RF,S,D	Ranobe, Manombo
<i>Accipiter madagascariensis</i>		NT	RF	Manombo
<i>Ardea humbloti</i>		EN	W	Fiherenana
<i>Charadrius thoracicus</i>		VU	W	Belanda, Ranobe
<i>Lophotibis cristata</i>		NT	T	Manombo
Habitat codes: S= spiny thicket, RF= riparian forest, T= transitional forest, W= water, O=open				

Four other Red List species were recorded during our survey, of which two (*Accipiter madagascariensis*, *Lophotibis cristata*) are classified as Near Threatened based on declining populations (BirdLife International 2008c, 2008d). *Ardea humbloti* is an endemic heron that is thinly distributed along the west coast of Madagascar, with an estimated global population of 1,500 (BirdLife International 2008e). We recorded this species only irregularly feeding in the Fiherenana River (four records in October–December 2002, which may represent the same individual, and one record in August 2003), but did not observe any evidence of breeding activity. *Charadrius thoracicus* is an endemic plover that breeds only on permanent or ephemeral wetlands throughout the south and west of Madagascar. It is classified as Vulnerable (BirdLife International 2008f), although recent research into its breeding ecology suggests that it may merit upgrading to Endangered (Zefania *et al.* 2008, Long *et al.* 2008). We recorded this species both at Ranobe (two records in March–April 2003) and at Belalanda (two records including one of ten individuals in April 2003 and one individual in November 2003), where it is sympatric with *C. tricoloris*, *C. pecuarius* and *C. hiaticula*. We could not confirm breeding of this species at either site.

## Conclusions and recommendations

A total of 130 bird species have been recorded in the proposed PK32-Ranobe protected area (124 in our survey, and 6 recorded by other authors), making the site the most avi-diverse in the south-west of Madagascar. Our findings therefore highlight the importance of the area for bird conservation, and serve to justify the establishment of the protected area. Our findings also highlight the importance of the range of sites and habitat types in contributing to the overall biodiversity of the PA; with 24.2% of species recorded at only one site, the importance of maximising the coverage of the protected area becomes paramount if the full bird diversity of the region is to receive some formal protection. Of particular importance are the wetlands of Ranobe and Belalanda, which represent the southernmost populations in the west of Madagascar of a number of wetland species, and the transitional forests to the east of Lac Ranobe, the only area in which we recorded *Monias benschi* and *Uratelornis chimaera*. The gallery and transitional forests of the Fiherenana and Manombo rivers harbour a number of species not recorded elsewhere during our survey, including a number of forest-dependent endemics with restricted distributions in the region. Given that only small relict stands of gallery forest remain, we recommend that this habitat be prioritised in the planning and management of the protected area.

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# Herpetofaunal observations on Eagle Island, Middle Brother, North Brother and Diego Garcia, with an overview of previous records in the Chagos Archipelago.

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**Abstract:** Eagle Island of the Chagos Archipelago is the second largest island of the largest coral atoll structure in the World and yet nothing is known of the island's terrestrial herpetofauna. Eagle Island was extensively surveyed for terrestrial reptiles and amphibians over a ten week period during the Chagos Ecological Restoration Project 2006. Nesting attempts of marine turtles were also recorded over the duration of the project. Herpetofaunal observations were also made on the neighbouring islands, Middle Brother and North Brother and the largest island of the archipelago Diego Garcia. Five species were encountered: green turtle *Chelonia mydas*, hawksbill turtle *Eretmochelys imbricata*, common house gecko *Hemidactylus frenatus*, mourning gecko *Lepidodactylus lugubris* and the marine toad *Bufo marinus*. These findings are presented with an overview of previous records of herpetofauna in the Chagos Archipelago.

**Key Words:** Chagos, Diego Garcia, Gecko, Bufo, Turtle.

## Introduction

The Chagos Archipelago is comprised of five emergent atolls including more than 60 small islands and represents the World's largest atoll structure. The archipelago is positioned approximately 500km to the South of the Maldives in the middle of the Indian Ocean. Herpetofaunal records do exist for Diego Garcia, the Peros Banhos and Salomon atolls, and two islands in the Great Chagos Bank. However, the terrestrial herpetofauna has not previously been surveyed on Eagle Island of the Great Chagos Bank. At 243ha Eagle Island is the second largest island in the archipelago and significantly larger than most other islands, the majority of which are below 100ha in size.

Eagle Island was extensively surveyed over a ten week period, between February and April 2006, during the Chagos Ecological Restoration Project to eradicate the island's introduced population of black rats *Rattus rattus*, Linnaeus 1758 (Hillman 2006, Meier 2006). Limited time was also spent on Middle Brother and North Brother of the Great Chagos Bank and Diego Garcia. Like Eagle Island, terrestrial herpetofauna has not previously been recorded for North Brother. Five species were recorded during this project; the green turtle *Chelonia mydas*, Linnaeus 1758, the hawksbill turtle *Eretmochelys imbricata*, Linnaeus 1766, the common house gecko *Hemidactylus frenatus*, Schlegel 1836, the mourning gecko *Lepidodactylus lugubris*, Duméril & Bibron 1836 and the marine toad *Bufo marinus*, Linnaeus 1758.

## A history of observations

All five species observed throughout the duration of the project have been previously recorded within the Chagos Archipelago. Bourne (1886a,b) recorded the presence of the green turtle and hawksbill turtle, the Mauritian gecko *Platydictylus mauritanicus*, Linnaeus 1758 and the mud tortoise *Geoemyda trijuga thermalis*, Schweigger 1812. *Platydictylus mauritanicus* is the former name for the Moorish gecko *Tarentola mauritanica*, which is found throughout the Mediterranean region. Bourne (1886a) suggests that the gecko probably arrived from Mauritius, although it has never been recorded there (Cole 2005, Cheke & Hume 2008). Bourne was most likely referring to the common house gecko, which is the most abundant non-native lizard in Mauritius and at a glance, is somewhat similar to the Moorish gecko in being a small greyish scansorial lizard. The mud tortoise described as *G. t. thermalis*, is the former name of the Sri Lanka black turtle or Ceylon terrapin *Melanochelys trijuga thermalis*, which was thought to have been introduced to Diego Garcia (Boulenger 1889, Deraniyagala 1939). The African mud turtle *Pelusios subniger*, Lacépède 1788 was recorded on Diego Garcia in the Percy Sladen Trust expedition to the Indian Ocean in 1905 by Gardiner & Cooper (1907) who suggested that the species was introduced from either Zanzibar or Madagascar. Both turtle species were thought to have died out by the 1940s, although turtles were reported in the 1970s it is unknown whether it was one or both species (see Lever 2003). From the Percy Sladen Trust expedition Boulenger (1908) identified specimens of the common house gecko collected from Diego Garcia, the Peros Banhos and Salomon atolls and specimens of the mourning gecko collected from Diego Garcia.

More recent herpetological surveys have been conducted in the Chagos Archipelago, which include the 1978/79 Joint Services Chagos Research Expedition (Dutton 1981) and the 1996 Friends of the Chagos Expedition (Barnett & Emms 1998). Only two reptile species were recorded in the 1970s expedition; the common house gecko and the hawksbill turtle (Dutton 1981). The 1990s expedition recorded three terrestrial species; the common house gecko, the mourning gecko and the marine toad (Barnett & Emms 1998). The common house gecko was recorded on Ile Diamant, Ile du Coin, Ile Yeye, Moresby Island and Petite Soeur of the Peros Banhos atoll; Ile Anglais, Ile Boddam and Ile Poule of the Salomon atoll; Danger Island and Middle Brother of the Great Chagos Bank; and Diego Garcia. The mourning geckos were recorded on Ile Takamaka of the Salomon atoll; Ile du Coin of the Peros Banhos atoll; and Diego Garcia. Barnett & Emms (1998) also record the marine toad as being very common on Diego Garcia. Nests of the hawksbill turtle were recorded on all 11 islands of the Salomon atoll and 11 of the 17 islands searched of the Peros Banhos atoll (Dutton 1981). However, it is thought that Dutton may have confused green turtle tracks and nests for those of hawksbills as significant numbers of both species were found nesting in a survey of 67 islands throughout the archipelago (Mortimer & Day 1999).

Recent introductions to Diego Garcia include the marine toad and the brown tree snake *Boiga irregularis*, Merrem 1982; fortunately the snake has been prevented from establishing, but the marine toad is common on the island (Fritts 1993, Barnett & Emms 1998, Cheke 2008, *pers. obs.*). In 2006 there were unsubstantiated accounts of

the mutilating gecko *Gehyra mutilata*, Wiegmann 1836 and the agamid lizard *Calotes versicolor*, Daudin 1802 on Diego Garcia. These two reptiles were not seen during the 2006 project, but an agamid lizard was observed on the island near Simpson Point in March 2007 by Jenny Daltry, Chris Hillman and Guntram Meier during a follow-up expedition to the 2006 Chagos Ecological Restoration Project (C. Hillman *pers. comm.*).

### Observations on Diego Garcia

Searches on Diego Garcia were limited between the harbour and Simpson Point in north-western arm of the island between the 1<sup>st</sup> and 3<sup>rd</sup> Feb and on the 25<sup>th</sup> April 2006. Nevertheless, three species were found, the common house gecko, mourning gecko and marine toad. The common house gecko (snout to vent length [SVL] $\pm$ SD = 51.6 $\pm$ 4.0mm, mass $\pm$ SD = 2.9 $\pm$ 0.6g, N = 6) were the most frequently encountered species and were found in abundance on all buildings and coastal vegetation (predominantly the trunks of coconut palms *Cocos nucifera*, L., and branches of *Scaevola taccada*, Gaertner-Roxb.) at night, but could also be heard calling at all times day or night in most locations. The mourning gecko (SVL $\pm$ SD = 42.8 $\pm$ 2.1mm, mass $\pm$ SD = 1.6 $\pm$ 0.4g, N = 6) were occasionally found on buildings occupied by the common house gecko, but were most abundant on roadside telegraph poles in the absence of the common house gecko. Marine toads were also encountered after heavy rainfall along the road verge leading to Simpson Point from the airport.

### Observations on Middle and North Brother

Middle Brother and North Brother were both visited on the 7<sup>th</sup> Feb 2006, between 1000hrs and 1230hrs and 1400hrs and 1430hrs, respectively. To prevent disturbance to the nesting seabird colonies only the coastal perimeter was surveyed on Middle Brother and a 100m stretch of coast on North Brother. Three common house geckos (SVL $\pm$ SD = 49.1 $\pm$ 2.6mm, mass $\pm$ SD = 2.7 $\pm$ 0.4g, N = 3) and two eggs from the same species were found beneath loose bark of fallen coconut palms and *Tournefortia argentea*, L.f., on Middle Brother. Nothing was heard or seen on North Brother, despite suitable habitat. However, owing to the restricted amount of time spent and limited areas surveyed little can be said about the absence of geckos.

### Observations on Eagle Island

Searches were made over the entire island, whilst creating more than 80km of tracks to set and service bait stations on a daily basis by team members of the Chagos Ecological Restoration Project (Hillman 2006, Meier 2006). Numerous additional searches were made in the day and night across the island and around the coastline. Four species were encountered; the green turtle, hawksbill turtle, common house gecko and mourning gecko.

Adult house geckos (SVL $\pm$ SD = 50.7 $\pm$ 3.3mm, mass $\pm$ SD = 2.8 $\pm$ 0.6g, N = 11) were mostly encountered at night on the trunks of coconut palms and the trunks and branches of *Guettada speciosa*, L., *Hibiscus tiliaceus*, L., *Morinda citrifolia*, L., *S.*



*taccada* and *T. argentea* at almost all locations across the island. House gecko calls could also be heard at all locations on the island, but individuals were rarely seen in areas of closed canopy palm forest or wetland mangrove dominated by *Lumnitzera racemosa*, Willd. (see Hillman 2006). All house geckos observed in the closed canopy palm forest were high within the palm fronds. Sub-adult and juvenile individuals were most often seen amongst the herbaceous ground layer in relatively open areas. In contrast to the house gecko on Eagle Island the abundance and distribution of the mourning gecko was respectively lower and more restricted. Mourning geckos ( $\text{SVL} \pm \text{SD} = 43.7 \pm 1.8 \text{ mm}$ ,  $\text{mass} \pm \text{SD} = 1.9 \pm 0.2 \text{ g}$ ,  $N = 5$ ) were frequently found close to and on the remains of buildings, on small boulders along the shoreline and also within the mangrove area on the western side of the island (see Hillman 2006). Mourning geckos were also encountered, albeit rarely, at other locations across the island on the trunks of *G. speciosa* and the fronds of coconut palms. Eggs of both gecko species were found in the areas where individuals were known to be present. Mourning geckos are ‘egg gluers’ attaching pairs of eggs directly to the substrate and often communally with several pairs of eggs glued at the same site. Mourning gecko eggs were mostly found within cavities of *L. racemosa* trunks and associated entanglements of *Cassytha filiformis*, L., above high-tide mark in the mangrove. Mourning gecko eggs were also found within crevices of coralline stone walls and upon palm fronds. House geckos deposit their eggs loosely in pairs within substrates and were mostly found behind loose bark, within litter collected at the base of palm fronds, and crevices and cavities within tree trunks.

All turtle observations, tracks and nests were recorded during daily walks along the coastline of Eagle Island by members of the Chagos Ecological Restoration Project. Twenty six individual turtle tracks were recorded along the sandy beach that ran clockwise from the northeast to the southeast coast of the island. The width of all tracks were measured and assigned by their size to either the green or hawksbill turtle (see Hillman 2006). After each track had been measured and the location recorded it was erased from the beach to prevent it being recorded again. Green turtles accounted for 23 of the tracks recorded and were mostly found along the narrow beach on the central east coast of the island (Hillman 2006). Green turtles were also the most common of the two species seen within the surrounding lagoon. Two of the tracks were made by hawksbill turtles, one of which was observed nesting early one morning on the northeast coast of the island (Hillman 2006). Of the two species seen within the lagoon, green turtles were the most common. These observations support the previous findings of Mortimer & Day (1999) that green turtle nest more frequently within the Great Chagos Bank area than hawksbill turtles.

## **Introductions of the terrestrial herpetofauna**

The terrestrial herpetofauna recorded over the past 120 years are known or at least thought to have been introduced by the early inhabitants. The marine toad is certainly a recent introduction that has established on Diego Garcia, arriving sometime in the 1980s (Lever 2003). The introduction of the cane toad, the agamid lizard and probable arrival mutilating gecko have most likely occurred accidentally or purposefully as a result of military activities and occupation of Diego Garcia (Cheke 2008). This is

known to be true at least for the brown tree snake. Both of the predominantly nocturnal gecko species are highly commensal with people and have been introduced to numerous locations outside of their natural range throughout the tropics and sub-tropics. However, there is some evidence to suggest that these two species may have arrived to the Chagos Archipelago naturally. The common house gecko is native throughout Asia and the Indo Pacific and has been introduced to at least nine locations within the Indian Ocean, although it is thought to be native to the Seychelles (Cheke 1984). The species is thought to have arrived from Sumatra by self dispersal, rafting on debris washed out to sea and carried by oceanic currents (Cheke 1984). If this is the case then the geckos are likely to have arrived in the Chagos by the same means, as the archipelago is positioned directly between Sumatra and the Seychelles. Likewise the mourning gecko, with a similar native distribution to the house gecko, is thought to have reached the island of Rodrigues within the Mascarenes by self dispersal across the Indian Ocean (EN. Arnold *pers. comm.*). The origins of the gecko species and how they arrived to the Chagos Archipelago remains unclear. Tail tips were collected from both gecko species from each population discovered on the islands. These samples have been deposited at the Natural History Museum (London) where subsequent genetic work may help toward determining the natural and unnatural spread and origin of these anthropogenic species throughout the Indian Ocean.

## Acknowledgements

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## Comparative biometrics of a Seychelles island *Borbo gemella* (Lepidoptera: Hesperiiinae) metapopulation

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### Introduction

*Borbo gemella* (Mabille) is widespread throughout Africa (Ackery, *et al.* 1995), including the malagasy subregion (Lawrence 2000; Gerlach & Matyot 2006). *B. gemella* has no recognized subspecies. Within Seychelles, it has been recorded from the islands of Mahé (Berger 1962; Fletcher 1910; Fryer 1912; Joannis 1894; Legrand 1965), Silhouette (Berger 1962; Fryer 1912; Gerlach, *et al.* 1997); Praslin (Berger 1962; Fletcher 1910; Fryer 1912; Joannis 1894), Aride (Aride Island Research Group 1999), Coetivy (Legrand 1965), Alphonse (Fletcher 1910; Holland 1896), Platte (Holland 1896), Curieuse (Hill, *et al.* no date) and Aldabra (Legrand 1965). Only recently has *B. gemella* being recorded from Cousine Island (Lawrence 2004; Lawrence 2005).

Although *B. gemella* is widespread, to date very little biometric work has been carried out on the various metapopulations of this species. This is particularly important for isolated island insect metapopulations, as these island individuals may show distinct morphological characteristics compared with continental ones (Vitousek, *et al.* 1995; Whittaker & Fernandez-Palacios 2007). In this short study, the size (i.e. wingspan) of *B. gemella* individuals collected on Cousine Island, Seychelles (4° 20' 41" S and 55° 38' 44" E) were measured. The data were then compared with published *B. gemella* sizes from various continental African sites.

### Results

Twelve *B. gemella* specimens collected on Cousine Island, Seychelles were examined. Of the twelve specimens, ten were male and two were female. All specimens were collected between 23 November 2003 and 8 December 2003. Six specimens are housed in the private collection of the author. The other six specimens are housed in the collections on Cousine Island, Seychelles. The wingspan of each specimen was measured to the nearest millimeter. Table 1 lists *B. gemella* wingspans (mm) for Cousine Island, Seychelles, compared with the published sizes (mm) for individuals from South Africa, Malawi and West Africa. For some of the published *B. gemella* sizes for the continental African sites, the forewing length was given instead of the wingspan. In these cases the forewing length was doubled and 3mm added for the width of the thorax. This gave a comparative value of butterfly wingspan. These cases are indicated in Table 1. From Table 1 it can be seen that the Seychelles individuals are smaller than

the continental African ones.

### Discussion

Clearly, the Cousine Island, Seychelles specimens are smaller than the continental African specimens. Berger (1962) also found that the Seychelles (specimens collected from Mahé, Silhouette, and Coetivy islands) individuals of *B. gemella* to be smaller than the continental African specimens. There are two possible explanations for the smaller size of the Seychelles specimens compared with continental African individuals.

Firstly, environmental breeding conditions on Cousine Island and the other Seychelles islands may not be ideal for *B. gemella*, resulting in smaller adults. Secondly, the smaller size of the island specimens compared with the continental specimens could indicate the first signs of morphological divergence occurring in the island individuals, possibly from genetic effects such as limited gene flow due to the geographical isolation of the Seychelles islands. Samways & Osborn (1998) found this to be the case for the migratory dragonfly *Pantala flavescens* (Fabricius) on Easter island, with island individuals differing in morphology, by being larger, and in behaviour to mainland ones. Although other *Borbo* species have been considered as migratory at certain times, for example *B. borbonica* (Henning *et al.* 1997), *B. gemella* is not considered migratory. This along with the great isolation of the Seychelles islands suggest that migrants rarely reach the Seychelles islands so limiting genetic exchange. Although the smaller size of the Seychelles individuals may be the first indications of morphological divergence due to geographical isolation, further genetic work would be required to confirm this.

**Table 1.** *Borbo gemella* biometrics for Cousine Island, Seychelles, South Africa, Malawi and West Africa

Location	Mean wingspan (mm)	Reference
Cousine, Island, Seychelles	Males: 29.4mm (29-30mm) (n=10) Females: both 31mm (n=2)	This study
South Africa	Males: 35-37mm Females: 40-42mm	Woodhall 2005
South Africa	Males: 35-39mm <sup>note 1</sup> Females: 40-42mm <sup>note 2</sup>	Henning, <i>et al.</i> 1997
Malawi	32mm	Gifford 1965
West Africa	35mm <sup>note 3</sup>	Larsen 2005

<sup>note 1</sup> Henning, *et al.* (1997) lists male forewing length as 16-18mm

<sup>note 2</sup> Henning, *et al.* (1997) lists female forewing length as 18.5-19.5mm

<sup>note 3</sup> Larsen (2005) lists the forewing length as 16mm

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## First record of the threatened hawkmoth *Temnora peckoveri* from Cousine Island, Seychelles

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Cousine Island is a small granitic island situated 4° 20' 41" S and 55° 38' 44" E. It is just over 1km long, 400m at its widest point and 27ha in area (Bourquin 1997). During the evening of the 25 April 2009, a *Temnora peckoveri* (Butler, 1876) hawkmoth (Lepidoptera: Sphingidae) (Fig. 1; Fig. 2) was attracted to lights on the northern coastal plateau of Cousine Island. The species was identified using keys from both Matyot (2005) and Pinhey (1962). Further confirmation of the species identification was made by I. Kitching. The wingspan of the specimen is 52 mm. The forewing uppersides are similar to *T. fumosa fumosa* (Walker 1856) but the ground colour is a darker brown resulting in the antemedian and postmedian bands being less conspicuous. Hindwing undersides are a grey ground colour with the median band being inconspicuous, and with a strong black spot between CuA1 and CuA2.

Although *peckoveri* was considered a subspecies of *Temnora fumosa* (Walker, 1856), it was elevated to species status by Turlin (1996). It was subsequently listed as one of the 52 *Temnora* species by Kitching & Cadiou (2000). Legrand (1965) gives its distribution (*Temnora fumosa peckoveri* in his paper) as Seychelles, Madagascar and Comoros. However, *T. peckoveri* is restricted to Madagascar and Seychelles only (Turlin 1996), with *Temnora fumosa chanudeti* Turlin, 1996 and *T. leighi* Rothschild & Jordan, 1915 occurring on the Comoros Islands (Kitching, pers. comm.).

Within Seychelles, this species has been recorded from the granitic islands of Mahe (1892, 1909, 1960, 1998-9) (Joannis 1894; Fryer 1912; Gerlach & Matyot 2006), Silhouette (1908, 1999) (Fryer 1912; Gerlach & Matyot 2006) and Denis Island (2003) (Matyot 2005; Gerlach & Matyot 2006). Known larval foodplant in Seychelles is *Morinda citrifolia* L. (Rubiaceae) (Matyot 2005). *T. peckoveri* is listed as Endangered/Vulnerable (B1abiii, 2abiii) in Seychelles (Gerlach & Matyot 2006). This threat assessment is based on the small number of specimens collected, and on it only being recorded from very few Seychelles islands. However, as *M. citrifolia* is widely distributed in Seychelles (Robertson 1989) it is very likely that *T. peckoveri* will occur on other Seychelles islands, and may just have been overlooked.

This brings the total number of hawkmoth species recorded from Cousine Island to three. The other two species being *Herse convolvuli* (L., 1758) and *Acherontia atropos* (L., 1758) (Lawrence 2005). Interestingly, the larval foodplant, *M. citrifolia*, is relatively abundant on Cousine Island, so breeding of *T. peckoveri* on Cousine Island is possible, although not yet confirmed.



**Fig 1.** *Temnora peckoveri* (upperside) hawkmoth collected from Cousine Island, Seychelles, 25 April 2009, J. Lawrence



**Fig 2.** *Temnora peckoveri* (underside) hawkmoth collected from Cousine Island, Seychelles, 25 April 2009, J. Lawrence

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We would like to thank Mr. M.F. Keeley for the opportunity of working on Cousine Island; Dr. I. Kitching for helping with the identification of the species as well as interesting discussions on the taxonomy and distribution of the *Temnora peckoveri* and *Temnora fumosa* species.

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## ***Euploea rogeri* (Lepidoptera: Danainae), a little known Seychelles butterfly**

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### **Introduction**

The butterfly genus *Euploea* Fabricius is a largely Indo-Australian genus represented by two extant species in the Afrotropical region (Ackery & Vane-Wright 1984). *Euploea euphon* (Fabricius) is found on the Mascarene Islands where it is represented by three distinct subspecies (Ackery *et al.* 1995). *E. euphon euphon* (Fabricius) occurs on Mauritius (Manders 1907; Williams 2007), *E. euphon goudotii* (Boisduval) on Reunion (Martire & Rochet 2008), and *E. euphon desjardinsii* (Guerin-Meneville) on Rodrigues (Vinson 1938), although the latter subspecies may be now extinct (Ackery *et al.* 1995). The other *Euploea* species, *Euploea mitra* Moore is confined to the granitic Seychelles islands of Mahe and Silhouette (Lawrence 2000; Gerlach & Matyot 2006). A record of *E. mitra* from Aldabra by Holland (1896) is believed to be an error (Fletcher 1912; Legrand 1965).

A further taxon, *Euploea rogeri* Geyer has been associated with Seychelles. Although the type specimen is lost (Legrand, 1965), it was apparently described from a specimen of unknown origin dating from around 1820 (Gerlach & Matyot 2006). This taxon is known only from two paintings in Hubner (1837) (Fig. 1). Legrand (1965) suggested that *rogeri* is synonymous with *mitra*. Furthermore, Aurivillius (1925) states that *E. rogeri* “somewhat recalls the female of *E. mitra*”. If *rogeri* is synonymous with *mitra*, then the name *rogeri* would take preference over *mitra*. The given locality is thought to be Seychelles, and for this reason alone, this taxon is often associated with *E. mitra* (Aurivillius 1925; Peter 1952). Ackery & Vane-Wright (1984) suggest that *rogeri* is more reminiscent of a nymphaline, and had it not been placed in *Crastia* (synonym of *Euploea*) it is doubtful that this taxon would ever have been associated with the Danainae. Talbot (1943) indicated that *rogeri* more closely resembles the Mauritius *E. euphon euphon*.

Clearly, there appears to be much confusion about the status of this taxon, including its higher classification. Using basic comparative morphological, along with wing pattern characteristics of the *E. rogeri* illustration and various Malagasy *Euploea* species and subspecies, this brief study aims to determine how similar *E. rogeri* is to the other Afrotropical *Euploea* taxa.

### **Methods and results**

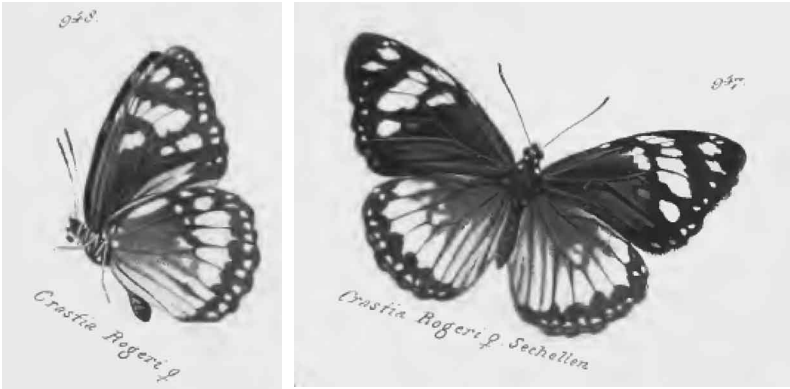
The ratio of forewing length (to the nearest 0.5mm) to the hindwing length (to the nearest 0.5mm) was compared between *E. rogeri*, *E. mitra*, *E. euphon euphon*, *E. euphon goudotii*, and *E. euphon desjardinsii*. As no specimens were available to

the author, and *E. rogeri* is only known from two paintings, wing measurements were made from the illustrations in Boisduval (1833)<sup>1</sup>, Hubner (1837)<sup>2</sup>, Aurivillius (1925)<sup>3</sup>, Legrand (1965)<sup>4</sup>, D'Abrera (1980)<sup>5</sup>, Ackery & Vane-Wright (1984)<sup>6</sup>, Desegaulx de Nolet (1984)<sup>7</sup>, Bowler (2006)<sup>8</sup>, Williams (2007)<sup>9</sup>, and Martire & Rochat (2008)<sup>10</sup>. A total of 29 Afrotropical *Euploea* illustrations were examined. The superscript indicates the applicable references in Table 1. A wing ratio was used as the size of each illustration examined varied.

Table 1 lists the species/subspecies, sample size, distribution, mean forewing/hindwing ratio and the reference to the illustrations used. Clearly, the forewing/hindwing ratio of *E. rogeri* is similar to the three *E. euphon* subspecies. The mean forewing/hindwing ratio of the three Mascarene subspecies combined is 1.32 which is similar to the forewing/hindwing ratio of 1.31 for *E. rogeri*. *E. mitra* and *E. rogeri* have quite dissimilar forewing/hindwing ratios.

**Table 1.** Afrotropical *Euploea* species/subspecies (Taxon), sample size (n), distribution, mean forewing/hindwing ratio (Ratio) and reference to the illustration used.

Taxon	N	Distribution	Ratio	References
<i>E. rogeri</i>	2	Seychelles	1.31	2
<i>E. mitra</i>	9	Seychelles	1.40	3, 4, 5, 6, 8
<i>E. euphon euphon</i>	7	Mauritius	1.32	1, 3, 5, 6, 7, 9
<i>E. euphon goudotti</i>	7	Reunion	1.33	1, 3, 5, 6, 7, 10
<i>E. euphon. desjardinsii</i>	4	Rodrigues	1.31	3, 5, 6



**Fig. 1.** Female *Euploea rogeri* Geyer, 1837 upperside (left) and underside (right) (originally named *Crastia rogeri*). (Hubner 1837)

## Discussion

Initial examination of the *E. rogeri* paintings (Fig. 1) gives the impression that the taxon is not an *Euploea* species at all, and is more similar to a Nymphaline species (following Ackery & Vane-Wright 1984). However, on closer examination *E. rogeri* does share similar characteristics with other Afrotropical *Euploea* species and subspecies. The forewing pattern of *E. rogeri* is similar to that of *E. mitra*. However, the white cells are quite a bit smaller on *E. rogeri* than *E. mitra*. Conversely, the hindwing pattern of *E. rogeri* is quite different to that of *E. mitra*, but superficially similar to *E. euphon euphon* from Mauritius (following Talbot 1943).

More light may be shed on this confusing situation when the forewing/hindwing ratio's are examined. The forewing lengths of *E. mitra* and *E. rogeri* are 40% and 31% respectively longer than their hindwings. This indicates that *E. rogeri* is unlikely to be an aberration of *E. mitra* as has been suggested (Legrand 1965; D'Abrera 1980), even though the forewing patterns are vaguely similar.

The forewing/hindwing ratios of *E. rogeri* and *E. euphon* are very similar. Maybe, *E. rogeri* could be considered a Seychelles subspecies of *E. euphon* that is now extinct. The three known subspecies of *E. euphon* all display varying degrees of white patterning on both their forewings and hindwings, but all are very similar in their forewing/hindwing ratios.

However, care should be taken with the scenario presented here. This study is based on small sample sizes and on measurements taken from illustrations. Although in the case of *E. rogeri* no specimens actually exist. Possibly, measurements taken from actual *E. mitra* and *E. euphon* specimens would give different results. Also, the accuracy of the *E. rogeri* paintings are not known, but are assumed to be accurate.

To summarise, there are five possible views on the status of *E. rogeri*. Firstly, it could be an aberration of *E. mitra* (Legrand 1965). Secondly, it may represent a distinct *Euploea* species (i.e. *E. rogeri*) (Hubner 1837), now extinct. Thirdly, it could represent an extinct Nymphaline species and is not an *Euploea* species (Ackery & Vane-Wright 1984). Fourthly, *E. rogeri* could be an extinct subspecies of some other Indo-Australian *Euploea* species. *E. rogeri* shows a superficial resemblance to various subspecies of *Euploea sylvestern* (Fabricius), *Euploea core* (Cramer), *Euploea algae* (Godart) and *Euploea climena* (Stoll). Finally, *E. rogeri* could be an extinct Seychelles subspecies of *E. euphon* as suggested here. The view presented here agrees with the observation of Talbot (1943) in that *E. rogeri* approaches *E. euphon euphon* in appearance. Unfortunately, without the actual *E. rogeri* specimen the truth may never be known.

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## ***Hypolimnas bolina* on Alphonse Island**

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On 1<sup>st</sup> April 2007 Susan Barclay and I were walking at the southeast point of Alphonse Island, among coastal vegetation, chiefly coconut *Cocos nucifera* and veloutyer *Scaevola sericea*. A large butterfly with a strikingly languid flight appeared and paused at various places along the sunlit vegetation, occasionally landing, flexing its wings 3 or 4 times before resting with wings closed for a minute or so before taking off again. After flying off more strongly northwards it would return again and repeat its performance, never settling for long, favouring the same stretch of *Scaevola*, until it disappeared for good after 20 minutes or so. I took several photographs, although the upperwings were difficult because at rest they were never exposed for long.

In appearance it resembled an oversized male *Hypolimnas missipus* (Linnaeus 1764), of which there were many around, but the flight was markedly lazier, the whitish patches on the upperwing not as white – in fact having a violet cast – and the underwing was not as contrastingly marked. Photographs subsequently showed the whitish upperwing patches as quite a bright violet blue, which they certainly weren't in the field.

After consulting Gerlach & Matyot (2006) and failing to find it, I sent pictures to Justin Gerlach who identified it as a male *H. bolina*, and this was confirmed by James Lawrence.



**Fig. 1.** *Hypolimnas bolina* on Alphonse island

The great eggfly *Hypolimnas bolina* (Linnaeus, 1758) has a wide distribution from Madagascar in the west to south and southeast Asia, islands of the South Pacific, parts of Australia, Japan and New Zealand. A purple-blue iridescence surrounds the white upperwing spots of the male. The closest population to Seychelles, in Madagascar, is of the race *H. b. jacintha* (Drury, 1773).

The occurrence took place during an influx of *H. misippus*, a regular visitor to Seychelles following strong northwesterlies during the northwest monsoon season November – April (as on this occasion), suggesting this individual *bolina* was a genuine immigrant rather than an arrival as pupa or larva in imported plant material.

Previous occurrence of this species in Seychelles is unclear: Hill & Currie (2007), in their account of *misippus*, suggest that *bolina* ‘also occurs in Seychelles’.

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## Colour change in the ghost pipefish *Solenostomus cyanopterus*

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There are four species of ghost pipefish found in the Indian and Pacific oceans: *Solenostomus cyanopterus*, which is found over a wide area, *S. halimeda* from the Indo-Pacific, *S. paradoxicus*, which is found near Australia and Madagascar, *S. armatus*, which is only found around Japan (Orr & Fritzsche 1993). All three species mimic weed, and can be found floating head down in weed beds, at depths of up to 30m, but mostly near the surface. They grow up to 17cm long, in that the female broods the eggs in a pouch made from specially modified pelvic fins (Playfair & Gunther 1866). They eat plankton, small crabs and fish fry.

On the 19<sup>th</sup> of December 2007, one 8cm long, dark brown young adult male specimen of *S. cyanopterus* was found in the coral rubble around La Passe, Silhouette Island, Seychelles. Only three have previously been recorded in the Seychelles before, at Mare Anglaise, Mahé Island (Gerlach 2001). Of the previously recorded individuals, two were a bright green colour and one dark brown. The cause of colour variation in the species is not known, but possibilities include variation and diet. The potential for colour change was investigated with the new record.

### Methods

The specimen collected on 19<sup>th</sup> December 2007 was kept for about 12 hours in an aquarium containing coral rubble and sand (similar to the original habitat), and then was moved to a smaller aquarium for study. This measured 30x20cm by 15cm deep, containing large amounts of green weed and no substrate. The colour pattern was described on placing the fish in the aquarium and on several occasions over the next 3 days.

### Results

Initially the fish was dark brown with irregular grey patches. After 4 hours of being in the green weed the rear half of the body and the base of the tail had begun to turn yellowish brown. The next morning (after 18 hours), the whole fish was yellow, with a large orange-brown patch around the eye and the underside of the beak. The edges of the fins and the tip of the tail were very dark brown, and there were visible brown spots along the spine.



**Fig. 1.** *Solenostomus cyanopterus* before capture (left) and after 18 hours (right)

## Discussion

The results of the experiment show that ghost pipefish change colour very slowly, lightening from brown to yellowish over a period of about 36 hours. This colour change enables them to live in various habitats such as *Sargassum*, green turtle grass and brown turtle grass. They are a slow moving fish, so slow change is normally sufficient to allow effective camouflage. The mechanism of colour change in this species has not been studied, in other fish it arises from changes in pigment cells, either as a result of rapid movement of chromatophores leading to physiological colour change or changes in chromatophore morphology and density leading to morphological colour change (Sugimoto 2002). The slow adaptation recorded here resembles morphological colour change but this process involves the death of chromatophores and is only very slowly reversible. Colour change in ghost pipefish is more likely to be physiological than morphological. Considerable variation in the rate of physiological colour change has been recorded (Kimler & Taylor 2002).

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